Christel M. Portengen

ENGENDERING GENDER

A neuroscientific examination of parental gender socialization in early childhood

ENGENDERING GENDER

A neuroscientific examination of parental gender socialization in early childhood

By Christel M. Portengen

Engendering Gender: A neuroscientific examination of parental gender socialization in early childhood
By Christel M. Portengen

ISBN: 9789039376560

Printing: Ridderprint, www.ridderprint.nl
Cover design: Karlijn Linssen
Layout and design: Harma Makken, persoonlijkproefschrift.nl

Engendering Gender

A neuroscientific examination of parental gender socialization in early childhood

Engendering Gender

Een neurowetenschappelijk onderzoek naar ouderlijke gendersocialisatie in de vroege kindertijd

(met een samenvatting in het Nederlands)

Proefschrift
ter verkrijging van de graad van doctor
aan de Universiteit Utrecht
op gezag van de rector magnificus, prof. dr. H. R. B. M. Kummeling,
ingevolge het besluit van het college voor promoties
in het openbaar te verdedigen
op vrijdag 19 april 2024 des middags te 2.15 uur

door
Christel Madeleine Portengen
geboren op 15 oktober 1992
te Valkenburg (Z-H)

Promotor: Prof. dr. A. L. van Baar
Copromotor: Dr. J. J. Endendijk

Beoordelingscommissie
Prof. dr. M. Deković
Prof. dr. C. Kemner
Prof. dr. J. Mesman
Prof. dr. G. W. J. M. Stevens
Prof. dr. M. A. Yerkes

Positionality statement

Before reading this dissertation, it is important to make you aware of the lens through which I have written my thesis over the last 4.5 years. I am a White heterosexual cisgender woman who was born and raised in the Netherlands. I am aware of the privileges that come with my social class as well as the effects this may have on my outlook on gender. I chose to study this topic to learn more about parental gender socialization in relation to the neuroscience of stereotyping and the consequences of stereotyping on children's development. Admittedly, whilst writing this dissertation, my increasing awareness of persisting sex/gender, race, and class discrimination have fueled my feminist views. Although as a researcher the goal is to remain objective, I do not want to deny the possibility that my background may have shaped the motivations and beliefs that nourished my research interests. By using standardized and validated tests and questionnaires, objective coding schemes, and with pre-registered aims and hypotheses that were derived from the scientific literature, I aim to have retained my objectivity.

Similarly, while my dissertation mainly speaks of and focuses on gender development in boys and girls and only includes data from mixed-gender couples, I do acknowledge the more diverse and dimensional nature of gender and sexual orientation. I would therefore like to explicitly mention that the future studies and research implications that derive from this dissertation are relevant for all children and parents regardless of their sex/gender or sexual orientation.

Table of contents

Chapter 1	General introduction	10
Chapter 2	A neurocognitive approach to studying processes underlying parents’ gender socialization	28
Chapter 3	Measuring the neural correlates of the violation of social expectations: A comparison of two experimental tasks	54
Chapter 4	Mothers’ and fathers’ neural responses toward gender-stereotype violations by their own children	78
Chapter 5	Gender-differentiated emotion socialization: Evoked by child behaviors or driven by parents’ neural responses toward gender-stereotype violations?	106
Chapter 6	Women are expected to smile: Preliminary evidence for the role of gender in the neurophysiological processing of adult emotional faces in 3-year-old children	136
Chapter 7	General discussion	160
References		178
Appendices		206
Summary		249
Nederlandse samenvatting (Dutch summary)		253
Dankwoord (Acknowledgements)		257
About the author		261
Publication list		263

1

General introduction

General introduction

Since the 21st century, sex and gender are acknowledged as distinct but overlapping constructs in the scientific literature (DuBois et al., 2021; Heidari et al., 2016). However, it took multiple feminist waves for society to recognize the distinction between a person's biological sex and a person's gender (i.e., the socially construed roles that are attached to a biological sex). Nowadays, the idea of gender as a binary construct is being replaced by gender as a spectrum of associations between one's own and the other gender (Castleberry, 2019; Egan & Perry, 2001; Twenge, 2023), and transgender and gender-diverse identities are progressively adopted (Åhs et al., 2018; Van Caenegem et al., 2015; Zucker, 2017). At the same time, there are contrasting ways in which (future) parents approach gender. The so-called 'gender-neutral baby movement' includes progressive parents who raise their babies in a gender-neutral way, letting the child decide for themselves which gender they identify with (i.e., the "theybies") (Dumas, 2014; Savage, 2022). By not revealing their baby's sex to the outside world, they want to protect their child from the social expectations that are associated with a gender. Notably, parallel to this movement emerged the massive trend of gender-reveal parties, in which parents announce the unborn baby's sex through extravagant reveals (Langmuir, 2020). By announcing the sex of the child to the world, parents take the first steps in creating a pink and blue environment for their infant (Gieseler, 2018). This so-called gender socialization process then continues when parents make gendered choices regarding the baby's name (Pilcher, 2017), announce the birth of their child by sending out gendered birth cards (Endendijk, 2022), or when painting and decorating the baby's room (MacPhee & Prendergast, 2019; Pomerleau et al., 1990). Although ample research examined the ways in which parents apply gender socialization in the family context (Endendijk et al., 2018b; Skinner & McHale, 2022), little research has focused on *why* parents are more (or less) likely to use gender socialization in their home environment. Therefore, this dissertation focuses on the factors that can predict parental gender socialization and how parental gender socialization is related to the development of gender stereotypes in early childhood.

Development and consequences of gender stereotypes in early childhood

With being assigned a sex at birth comes a set of expectations about the behaviors, roles, and characteristics that are associated with one's gender. A distinction should be made between gender stereotypes and gender attitudes. Gender stereotypes differ from gender attitudes in the presence of an evaluative component. Gender stereotypes represent (non-valenced) associations between the concept 'gender' and its related attributes (e.g., associating girls with pink), whereas gender attitude refers to the (valenced) evaluation of gender-related behaviors (e.g., it is inappropriate for boys to cry) (Greenwald et al., 2002). Children and adults who violate gender stereotypes and attitudes by their own behavior or choices often receive negative responses from the social environment (Koenig, 2018; Rudman et al., 2012a; Rudman et al., 2012b).

Children start developing gender-stereotyped knowledge at an early age. At 18 months, children's knowledge of gender stereotypes is evident through their ability to match toys with the appropriate gender and by looking longer at stimuli that violate metaphorical (e.g., a heart followed by a male face) (Eichstedt et al., 2002) or social gender stereotypes (e.g., a woman putting on a tie) (Hill & Flom, 2007; Poulin-Dubois et al., 2002; Serbin et al., 2001; Serbin et al., 2002; Weinraub et al., 1984). This gendered knowledge steadily increases after the age of 3 throughout childhood (Banse et al., 2010; Signorella et al., 1993). By the time children go to elementary school they have already obtained gender-stereotyped beliefs about the roles and academic abilities of boys and girls (Bian et al., 2017; Cvencek et al., 2011; Signorella et al., 1993).

Gender stereotypes are apparent in multiple domains, two of which are examined in this dissertation. First, in the domain of toy preference, there is ample evidence that most parents and non-parents expect boys and girls to have gender-typical toy interests and play styles (Blakemore & Centers, 2005; Fisher-Thompson, 1993; Kollmayer et al., 2018; Todd et al., 2018; Weisgram & Bruun, 2018). For example, boys are expected to play with vehicles or toy soldiers, whereas for girls playing with dolls or jewelry is expected more. Second, gender stereotypes exist in the domain of traits, behaviors, and emotions. Boys are expected to have more masculine traits, such as being dominant, independent, and competitive, and girls are expected to possess more feminine traits (e.g., being gentle, sympathetic, weak, shy, and feminine-looking) (Koenig, 2018). Regarding emotions, women are seen as more emotional but evidence for this claim is not consistently found across studies (Barrett et al., 1998; Fischer, 1993; Simon & Nath, 2004). Girls are often expected to express more submissive emotions (e.g. sadness, fear) and to convey social smiles, whereas boys are expected to display more disharmonious emotions (e.g., anger, joy at the expense of others) (Brody & Hall, 2008; Chaplin & Aldao, 2013; Plant et al., 2000). This gender stereotyping of emotions already emerges during early childhood (Birnbaum & Chemelski, 1984).

The gendered expectations that people have of children's preferences and behaviors play a role in children's cognitive, social, and emotional development later in life (Weisgram, 2022). For example, feminine toy-play has been related to enhanced comforting skills among preschool girls, whereas preschool boys' engagement in masculine toy play was associated with aggression (Li & Wong, 2016; Wong & Yeung, 2019). With regard to cognitive development, boys' use of spatial toys (e.g., blocks, cars) was related to enhanced spatial skills (Jirout & Newcombe, 2015). Moreover, boys tend to purposefully hide submissive emotions, especially among peers (Brody & Hall, 2008). Consequently, internalizing problems, and anxiety specifically, are more common among girls/women and gender-diverse people than boys/men (Kuvalanka et al., 2017; Yunger et al., 2004). Externalizing symptoms, on the other hand, are more frequent among boys/men than girls/women (Maccoby, 1998). Thus, gender stereotypes develop at an early age and appear to be related to gender differences in the social, cognitive, and emotional development of children.

Parental gender socialization in the home context

Children and adolescents learn about the societal expectations associated with gender through their social environments. This gender socialization process occurs throughout the lifespan, but is most intensive during early and middle childhood (Arnett, 2015; Endendijk et al., 2018b; Smetana et al., 2015). Parents are children's main sources of gendered information in early childhood (Leaper & Farkas, 2015). To increase our understanding of why parents socialize their children to be gender-(a)typical, this dissertation focuses on the predictors of parental gender socialization in the home context. This section starts with several theoretical frameworks that describe how gender socialization plays a role in children's gender development. Next, several types of parental gender socialization during early childhood are discussed.

Theoretical models guiding research in this dissertation

First, **social learning theories** describe that children's gendered behavior is shaped through reinforcement of gender-appropriate behaviors and punishment of gender-inappropriate behaviors (Bandura, 1969; Bandura & Walters, 1977). Moreover, children learn about gender roles and appropriate behavior for their gender through the observation and imitation of gendered behaviors of parents, particularly same-gender parents (Bandura, 1969; Bandura & Walters, 1977; Bussey & Bandura, 1999). From the classical social learning perspective, children are viewed as somewhat passive recipients of gender-stereotyped information and they play a minor role in their own gender development.

Second, according to the **gender schema theories** (GSTs) (Bem, 1981, 1983; Martin & Halverson, 1981) children do not merely passively absorb information about gender from their parents or within the family context. Instead, children also play an active role in their gender socialization through their gender schemas. Gender schemas are cognitive frameworks through which gendered information from the environment is encoded and organized, allowing children to selectively attend to and remember information that is relevant for their gender. GSTs also highlight the role of internal motivation to regulate behaviors in alignment with children's gender schemas (e.g., motivating children to behave in gender-conforming ways).

Last, the **gendered family process model** integrates biological, social, and psychological factors to explain gender socialization in the family context (Endendijk et al., 2018b). Most relevant to this dissertation in this model is the role of parents' gender cognitions and children's gender-typed behaviors in parental gender socialization. Parents' gender cognitions are bidirectionally related to parental gender socialization, and parents' gender cognitions are fueled by children's display of gender-typed behaviors. Moreover, the model includes a bidirectional link between children's gender-typed behaviors and parental gender socialization. On the one hand, parental gender socialization can reinforce gender-typed behaviors among children. Conversely, children's gender-typed behaviors may also evoke differential treatment in parents. Last, the role of family gender composition is highlighted, in which the gender of parents, children, and siblings is assumed to affect family members' gender cognitions and behaviors, as well as to moderate the relations between gender cognitions, parental gender socialization, and children's gender-typed behaviors.

Parental gender socialization during early childhood

Parents can employ several types of gender socialization (Endendijk et al., 2018b), of which the following are relevant to this dissertation. Parents can use gendered communication to convey gendered information to their children, for example through their use of gender labels (Gelman et al., 2004; van der Pol et al., 2015) or by making evaluative comments about behavior, emotions, or gender-stereotyped activities (e.g., "boys don't wear princess dresses") (Endendijk et al., 2014). Moreover, parents can employ gender-differentiated parenting strategies (Lytton & Romney, 1991). For example, parents are more likely to use physical punishment with disobedient boys than with girls (Endendijk et al., 2017; Lytton & Romney, 1991). Parents are also more likely to engage in rough-and-tumble play with sons than daughters and to engage more in pretend-play with daughters than sons (Lindsey & Mize, 2001). Furthermore, parents tend to discourage their sons to express fear and sadness but tolerate boys' expression of anger more than for daughters (Chaplin et al., 2010; Fivush & Buckner, 2000).

However, evidence for gender-differentiated parenting is mixed, with some but not many differences found between parenting practices used with boys versus girls (Endendijk et al., 2016; Lytton & Romney, 1991). Apart from encouragement of gender-typed activities, meta-analytic evidence shows that parents do not seem to differentiate much between their sons and daughters (Endendijk et al., 2016; Lytton & Romney, 1991). Social desirability or a lack of insight in one's behavior might influence the degree to which people can report on their own (gender) stereotyping and socialization (Greenwald et al., 2002; Greenwald & Krieger, 2006). Scholars have thus argued that gender socialization is thought to be more subtle and better captured with implicit measures (e.g., observational studies) rather than explicit measures (e.g., questionnaires) (Mesman & Groeneveld, 2018). Implicit gender socialization in this case means that parents might not be aware of their gender socialization or might not intend to convey gendered information onto their child (Mesman & Groeneveld, 2018). Therefore, this dissertation used observational tasks and neuroscientific measures to study parental gender socialization in the home context.

Predictors of parental gender socialization

That parental gender socialization is subtle and implicit cannot explain why some parents are more likely to employ gender socialization (and throw gender-reveal parties) whereas other parents aim to parent in a gender-neutral way. Therefore, more insights into the predictors of parental gender socialization is needed to help in explaining the different gender socialization trends that emerged since the 21st century. With the use of GSTs (Bem, 1981, 1983; Martin & Halverson, 1981) and Amodio (2014)'s neural model of stereotyping, two types of parental predictors of gender socialization have been identified: parents' gender cognitions and parents' neural responses to gendered information. Moreover, according to the gendered family process model, children's gender-typed behaviors can also evoke differential treatment of boys and girls in parents (Endendijk et al., 2018b).

Parents' gender cognitions

Gender cognitions is an umbrella term encompassing all the beliefs a person holds about the self and others in terms of gender. These beliefs encompass several types of gender cognitions, including gender attitudes, gender stereotypes, gender attributions, gender essentialism, gender identity, and sexism. From GSTs it can be argued that gender cognitions provide social standards that guide parents' behaviors (Bem, 1981, 1983; Martin & Halverson, 1981). As parents often perceive their children as extensions of themselves, these social standards extend to their children's behaviors as well (Montemayor & Ranganathan, 2012). Consequently, parents are inclined to employ gender socialization as a means of aligning their children's gendered behavior with parents' own gendered standards, which, in turn, are fueled by the societal norms regarding gender preferences and behaviors (Wood & Eagly, 2012).

However, there are individual differences in the extent to which parents endorse and reinforce gender stereotypes, depending on the strength of their gender cognitions. Parents with strong gender cognitions are presumed to be more likely to employ gender socialization to ensure that their children's preferences and behaviors conform to society's gender norms (Bem, 1981, 1983). In this case, parents can encourage their daughters to play with dolls rather than toy soldiers. Conversely, parents with more egalitarian gender cognitions might be more inclined to employ gender-neutral socialization (e.g., emphasize similarities between boys and girls rather than differences). Moreover, some parents might be more or less motivated to parent without gender stereotypes. This motivation stems from an internal desire from parents to regulate their gender socialization behaviors, thereby avoiding enacting their gendered beliefs (Bem, 1981). This motivation is then able to counteract a parent's automatic evaluations of children's gender-(non)conforming behaviors (Devine et al., 2002; Plant & Devine, 1998).

Parents' neural processing of gendered information

People categorize and process the social information that they obtain from their environment; this is often done subconsciously and automatic. This categorization is adaptive since it facilitates fast and effortless processing of (social) information. However, our complex social world requires some level of behavioral control over our automatic evaluations, to decrease the influence that stereotypes have over our behavior. By using neuroscientific measures, social scientists have gained insight into when and how gender-stereotyped information is processed. Moreover, because of the implicit and socially sensitive nature of gender stereotyping, neurocognitive measures can better capture these implicit processes underlying gender stereotypes and socialization than self-report measures (Greenwald et al., 2002).

Electroencephalography (EEG) measurements can provide information about the temporal processing of gendered information, due to its millisecond temporal resolution. EEG uses electrodes placed on the scalp to record voltage potentials that result from currents flowing in and around a group of neurons. Event-related potentials (ERPs) are epochs of averaged waveforms of neuronal activity around a certain timepoint of interest, often centered around the presentation of a stimulus. ERP studies use comparisons of neural activation around the presentation of gender-stereotype violations versus confirmations to make inferences about the degree of conscious (or subconscious) processing (Cunningham et al., 2004; Greenwald et al., 2002). These studies have pointed toward several early occipitoparietal components (P1, N1, P2), mainly responsible for attentional and information processing, and reflecting pre-conscious gender-differentiated processing of information (Di Russo et al., 2003; Novitskiy et al., 2011). In addition, two later components (P3, LPP) have been found to be modulated by gender stereotypes. The P3 indexes stimulus-evoked surprise, as well as the updating of memory representation evoked by the unexpectedness of the stimulus (Bartholow & Dickter, 2007; Mars et al., 2008). The late positive potential (LPP) functions as a proxy of motivational salience (Hajcak et al., 2009).

There are also indications that the neural processing of gender-stereotyped information is not the same for everyone. Instead, there are individual differences in the processing of gendered information based on people's gender cognitions and their own gender. For example, several studies have found that the differences in ERP mean amplitudes towards (gendered) expectancy violations and (gendered) expectancy confirmations depended on the degree to which people held more traditional or flexible (gender) stereotypes and attitudes (Canal et al., 2015; Endendijk et al., 2019a; Endendijk et al., 2019b; Healy et al., 2015). Similarly, there are indications that the neural processing of gender stereotypes differs for men and women, with men showing stronger neural responses to gender-stereotype violations than women (Proverbio et al., 2018).

An important topic for further investigation is whether the neural processing of gendered information is also related to parents' use of gender socialization in the home context. To date, only two studies have investigated the link between parents' brain responses to gender and actual parenting behaviors in the home context. Endendijk et al. (2019b) found that the degree to which mothers' neural responses to gender-stereotype violations and confirmations about toys differs was related to their use of evaluative comments about gendered behaviors during picture book reading with their child. Mothers with larger N2/P3 mean amplitude differences towards gender-stereotype violations and confirmations were more likely to make positive comments about gendered behavior that confirmed stereotyped expectations (e.g., a boy playing with cars) (Endendijk et al., 2019b). Importantly, these neural measures appeared to be better predictors of mothers' gendered communication than their levels of implicit or explicit gender stereotypes (Endendijk et al., 2019b). In another study, fathers of sons were found to use more rough-and-tumble play and achievement language than fathers of daughters (Mascaro et al., 2017). In contrast, fathers of daughters used more analytical and emotional language, sang more, and were more attentively engaged with their daughters than fathers of sons (Mascaro et al., 2017). Importantly, in this study, fathers' neural responses to their own children's emotional faces were related to their interactions with their children. Fathers' with enhanced medial orbitofrontal cortex (OFC) activity towards their son's neutral facial expression were also more likely to engage in rough-and-tumble play with their sons, whereas fathers' medial OFC activity toward their son's and daughter's happy faces was negatively related to the amount of time fathers engaged in rough-and-tumble play, regardless of the gender of their child (Mascaro et al., 2017). Together, these studies highlight the role of brain responses to gendered information in parental gender socialization of their children.

Children's gender-typed behaviors and preferences

According to the gendered family process model, there is a bidirectional link between parental gender socialization and children's gender-typed behaviors and preferences (Endendijk et al., 2018b). However, this reciprocity within parent-child dyads is often not taken into account in gender socialization research. When children show gender-typed (or atypical) behaviors, their parents might incorporate this behavior in their gender schemas (Bem, 1981, 1983; Martin & Halverson, 1981). For example, when a daughter frightens more easily than a son, parents might start to associate this fearfulness more with girls than boys. Consequently, parents might then more elaborately discuss the causes and consequences of fear with their daughter than their son. Although much research assumes that children's gender-typed behaviors result from parental gender socialization, only a few longitudinal studies can support this claim. For instance, when fathers were more likely to use physical control strategies with boys than girls, boys showed higher levels of aggression than girls a year later, even when controlling for initial gender differences in aggression (Endendijk et al., 2017). Nonetheless, this does not eliminate the possibility that gender-differentiated parenting might be elicited by biologically predisposed gender differences in child behaviors. Therefore, in this dissertation, children's gender-typed behaviors are included as predictor of parental gender socialization.

Within- versus between-family comparisons

Importantly, most of the studies examining parental gender socialization have compared parents of sons with parents of daughters. However, family gender composition also plays an important role in parental gender socialization (Endendijk et al., 2018b). Mixed-gender siblings have been found to have either a gender-intensifying (McHale et al., 1999; McHale et al., 2000) or a gender-neutralizing effect (Endendijk et al., 2013; Endendijk et al., 2014). For instance, parents are more likely to employ gender-differentiated parenting in domains such as parental warmth and involvement in families with mixed-gender siblings than in families with same-gender siblings (McHale et al., 2000). In addition, mixed-gender siblings were found to exhibit more gender-typical behaviors than same-gender siblings (McHale et al., 1999; McHale et al., 2000). This is especially true when parents hold more traditional gender attitudes (McHale et al., 1999). On the other hand, fathers of mixed-gender siblings held less traditional implicit gender stereotypes and were less likely to confirm gender-stereotyped behavior during gender talk than fathers of same-gender siblings (Endendijk et al., 2013; Endendijk et al., 2014). Moreover, children in mixed-gender sibling constellations have also been found to display less gender-typed behavior (Kuchirko et al., 2021). Thus, although sibling gender constellation appears to play a role in gender socialization and children's gender development, the effect this has on parental gender socialization remains inconsistent.

Importantly, comparing parents of sons with parents of daughters does not reveal how parents treat their sons and daughters differently when they grow up in the same household. By adopting a within-family approach, we decrease the chance that parents' differential socialization of sons and daughters is explained by other family variables (e.g., early social environment, class, etc.) than gender, since the same parent(s) would socialize sons and daughters. It is therefore that this dissertation has adopted a within-family design to examine parental gender socialization with mixed-gender siblings.

Aim and research questions of this dissertation

The aim of this dissertation is to examine the predictors and consequences of parental gender socialization in early childhood. To investigate this aim, the following research questions (RQs) are formulated:

1. Which key predictors of parental gender socialization can be identified from the scientific literature?
2. Are parents' brain responses toward gender stereotypes related to their gender socialization practices in the home context?
3. Are children's gender-typed behaviors related to parental gender socialization in the home context?
4. Are the effects of parental gender socialization reflected in preschool children's gender stereotypes?

The scientific literature on gender and gender development uses a variety of definitions for related concepts. Table 1.1 therefore contains a glossary with gender-related terms and their definitions as used in this dissertation.

Table 1.1 Glossary with terms used throughout this dissertation.

Term	Definition	Reference
Gender	The social meaning attached to a biological sex.	
Gender attitudes	An association between valence and a gender group. This includes positive and negative evaluations of the behaviors, roles and characteristics for men and women, as well as intergroup attitudes.	Greenwald et al. (2002)
Gender attributions	Gender-differentiated inferences and beliefs parents have about the causes of their children's behaviors, achievements, and preferences.	Reyna (2000)
Gender cognitions / gender schemas	Cognitive structures that contain gender-related information that shape how a person processes their social environment. These include all beliefs about the self and others in terms of gender. Attitudes, attributions, essentialism, identity, stereotypes, and sexism are all types of gender cognitions.	Bem (1981); Martin and Halverson (1981)
Gender essentialism	The idea that members of each gender share an (innate) essence that causes gender-specific characteristics to emerge.	Gelman (2003)
Gender identity	The subjective sense of belongingness toward one's gender and the other gender, and whether this conforms to one's assigned sex at birth.	Martin et al. (2017)
Gender socialization	The ways in which children learn about the expectations associated with gender through their social and digital environments.	Henslin (1981)
Gender stereotypes	The associations between men/boys and women/girls with their gender-typed behaviors, roles, and characteristics.	Greenwald et al. (2002)
Sexism		Glick and Fiske (1996)
Benevolent	Attitudes toward women based on subjectively positive stereotypes for the perceiver that tend to elicit prosocial or intimacy-seeking behaviors.	
Hostile	Aversive attitudes toward women based on negative stereotypes that tend to elicit hostile behaviors.	Glick and Fiske (1996)

Project design

For this dissertation, three datasets have been used that are obtained from two independent studies. Below, the selection criteria and aims of these studies are discussed. Table 1.2 provides an overview of the sample characteristics of these studies.

Table 1.2 Overview of data used per chapter of this dissertation.

Ch.	Study type	Dataset	Participants [age in years]	Outcome variables	Predictors	Stereotype domain
2	Literature review			Parental gender socialization	Gender cognitions Neural processes	
3	Empirical study	PBPB pilot	14 men, 11 women [22-31]	ERP mean amplitude differences during Implicit Association Test during Impression Formation Task	Gender stereotypes	Toy preferences Problem behaviors
4	Empirical study	PBPB	70 fathers, 66 mothers [29-53]	ERP mean amplitude differences during trials including own children during trials including unknown children	Gender stereotypes	Toy preferences Problem behaviors
5	Empirical study	PBPB	70 fathers, 66 mothers [29-53] 70 sons, 70 daughters [3-6]	Parental gender-differentiated emotion socialization	ERPs toward gender stereotypes Children's behavior expressions	Problem behaviors
6	Empirical study	YOUth	33 boys, 39 girls [2.5 – 3.5]	ERP mean amplitude differences	Gender stereotypes	Emotions

Note. PBPB = Parenting Beyond Pink & Blue. ERP = event-related potential.

Parenting Beyond Pink & Blue

This dissertation primarily builds on one multimethod, within-family design study that was performed between September 2020 – June 2022. In this study, fathers and mothers with at least one son and one daughter between the ages 3 – 6 years were invited to partake in a 3-hour testing day at their homes. Exclusion criteria were neurological diseases (e.g., Parkinson), a history of epileptic seizures, or insufficient knowledge of the Dutch language to complete the tasks and questionnaires. During this home visit, EEG measurements were obtained whilst parents performed an Impression Formation Task. Moreover, parents participated in an observation session with their participating son and daughter, in which they were asked to perform several tasks whilst being videotaped. Last, parents filled out several questionnaires about their attitudes toward child gender-typed behaviors, and their son's and daughter's gender-typed behaviors and interests, problem behaviors, and empathy. Chapter 4 and Chapter 5 in this dissertation report on the data gathered in this study.

Prior to this data collection, a pilot study was performed to examine the effectiveness of two frequently used stereotyping tasks (Impression Formation Task and Implicit Association Test) in eliciting neural mean amplitude differences between gender-stereotype violations and confirmations. For this pilot study, 25 adults partook in an EEG session whilst performing two experimental tasks. Exclusion criteria were neurological diseases (e.g., Parkinson) or a history of epileptic seizures. Chapter 3 reports on the findings obtained using this dataset.

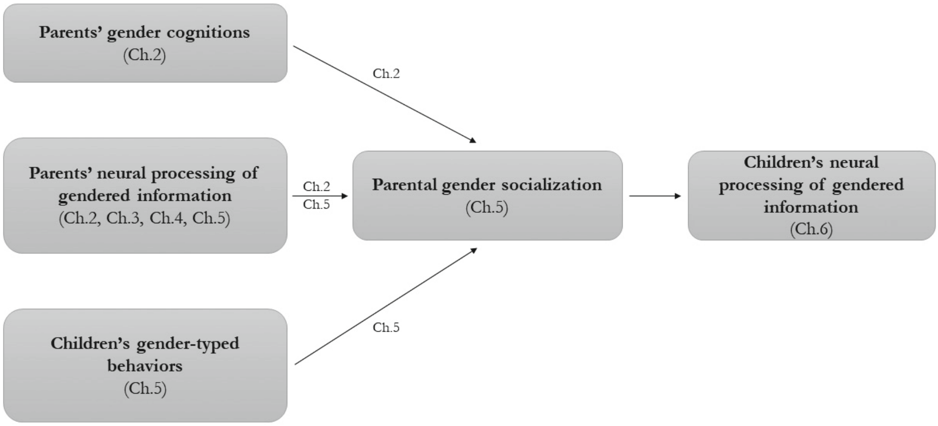
YOUth cohort study

The third sample included in this dissertation was obtained from the YOUth Cohort Study (https://www.uu.nl/en/research/youth-cohort-study). The YOUth Cohort Study is a Dutch population-based longitudinal cohort study that examines the dynamics of psychological, biological, and environmental processes in the development of social competence and self-regulation of children (for more detailed information, see Onland-Moret et al., 2020). The YOUth Cohort Study consists of two separate cohorts: the Baby & Child cohort follows infants from 20-weeks gestational age until the age of 6 years. The Child & Adolescent cohort follows children aged 8 years until 16 years. Chapter 6 reports on the EEG data from the 'around-3-years wave' of the Baby & Child cohort. Exclusion criteria for the YOUth Baby & Child cohort were mental or physical restrictions that prevented the child or parent from completing tasks during testing days or parents having insufficient understanding of the Dutch language to understand instructions and fill out questionnaires.

Outline of this dissertation

The aim of this dissertation is to examine the predictors of parental gender socialization in early childhood and whether consequences of parental gender socialization might already be visible in preschool children's gender stereotypes. To address this aim, the following steps were taken (see Figure 1.1 for a visual presentation of the aim and chapter overview). First, a literature review was conducted to create an overview of the cognitive and neural predictors of parental gender socialization (RQ1). The findings of this literature review are presented in chapter 2. In chapter 3, it is examined which of two often-used tasks in implicit (gender) stereotype research is better equipped to capture the neural processing of gender stereotypes using EEG measurements (RQ2). In chapter 4, parents' neural processing of gender-stereotype violations and confirmations are explored (RQ2). In addition, this study examines whether these neural processes differ if the gender-stereotype violations and confirmations concern parents' own children or unknown children. In chapter 5, it is examined whether (a) parents' neural processing elicited by gender-stereotyped information about parents' own children (RQ2), (b) gender differences in parents' son's and daughter's emotions and behaviors (RQ3), or (c) the interplay between these two factors are better predictors of parental gender socialization. Last, it is explored whether young children (whose gender development is primarily formed through their parents' gender socialization) already show preliminary signs of gender stereotyping in their neural processing of emotions (RQ4). The results of this study are reported in chapter 6. Finally, in chapter 7, the findings of chapter 2 – 6 are integrated in a general discussion and discussed in light of the theoretical and empirical frameworks discussed throughout this dissertation. Additionally, chapter 7 highlights limitations of this dissertation as well as the implications of these findings for research on the intersection of neuroscience, gender development, and parenting.

Figure 1.1 Overview of the aim of this dissertation and the concepts and associations studied in each chapter.



2

A neurocognitive approach to studying processes underlying parents' gender socialization

Christel M. Portengen, Anneloes L. van Baar, & Joyce J. Endendijk
Clinical Child and Family Studies, Utrecht University, Utrecht, the Netherlands

This chapter is published as: Portengen, C.M., van Baar, A.L., & Endendijk, J.J. (2023). A neurocognitive approach to studying processes underlying parents' gender socialization. *Frontiers in Psychology, 13*, 1-15.
https://doi.org/10.3389/fpsyg.2022.1054886

Abstract

Parental gender socialization refers to ways in which parents teach their children social expectations associated with gender. Relatively little is known about the mechanisms underlying gender socialization. An overview of cognitive and neural processes underlying parental gender socialization is provided. Regarding cognitive processes, evidence exists that parents' implicit and explicit gender stereotypes, attitudes, and gendered attributions are implicated in gender socialization. Other cognitive factors, such as intergroup attitudes, gender essentialism, internal motivation for parenting without gender stereotypes, gender identity, and conflict resolution are theoretically relevant mechanisms underlying gender socialization, but need further investigation. Regarding neural processes, studies demonstrated that attentional processing, conflict monitoring, behavior regulation, and reward processing might underlie stereotypes and biased behavior. However, more research is necessary to test whether these neural processes are also related to parental gender socialization. Based on this overview, a framework is presented of neural and cognitive factors that were theoretically or empirically related to gender socialization.

Introduction

Gender is an important category that shapes children's social lives (Blakemore et al., 2008). This starts already before birth, when parents decorate the baby's room, or decide upon the name the baby is given. These decisions represent the first indications of parental gender socialization, which comprises all intentional and unintentional ways in which parents teach their children the social expectations and attitudes associated with gender (Henslin, 1981; Endendijk et al., 2018b). Parents can employ several types of gender socialization. First, parents can (unintentionally) create gender-specific environments for children through the provision of activities, chores, books, toys, resources, or opportunities (i.e., channeling or shaping; Blakemore et al., 2008; Dittman et al., 2022). Second, parents may use different parenting practices with their sons and daughters, which is known as gender-differentiated parenting (Endendijk et al., 2016). Third, parents appear to respond more negatively to behavior that violates gendered expectations (e.g., a boy who plays with dolls) than when gender stereotypes are confirmed (e.g., a boy who plays with cars; Smetana, 1989; Morrongiello & Dawber, 2000; Martin & Ross, 2005). Fourth, parents serve as models for appropriate gender-role behavior through their own behaviors, interests, and division of work and household tasks (Bandura, 1969; Bandura & Walters, 1977; Bussey & Bandura, 1984, 1999; Endendijk & Portengen, 2021). Fifth, parents may use gendered communication, such as gender labeling (e.g., boy, girl, he, she) or evaluative comments that emphasize the appropriateness of gender-typical behaviors (e.g., "Look, those girls are fighting. That is not nice!") (Endendijk et al., 2014). Importantly, it was argued by Mesman and Groeneveld (2018) that "gender socialization is expressed primarily in specific parenting practices (rather than broad parenting styles) and mostly implicitly (rather than explicitly)" (Mesman & Groeneveld, 2018, p. 23).

There is ample evidence that parental gender socialization is associated with the development of gender stereotypes (Halpern & Perry-Jenkins, 2016), as well as gender differences in language skills (Pruden & Levine, 2017), academic achievements (Updegraff et al., 1996), occupational preferences (Sandberg et al., 1991), and problem behaviors (Endendijk et al., 2017) in children and adolescents. Even though there is a large body of research demonstrating the consequences of parental gender socialization for the (gender) development of children and adolescents (for a review, see Endendijk et al., 2018b; Morawska, 2020), we still know relatively little about the factors and mechanisms underlying and explaining gender socialization. However, more insight into these underlying mechanisms would lead to a better understanding *why* some parents are more likely to employ gender socialization with their children than others. Moreover, these mechanisms can be targeted in parenting interventions aimed at reducing gender inequality in future generations of children.

Neurocognitive frameworks and research could provide valuable insights into the underlying mechanisms of gender socialization for several reasons. First, parental gender socialization has been characterized as a rather implicit process (Mesman & Groeneveld, 2018). 'Implicit' in this context indicates that parents might not be aware that they convey gendered information to their children, that parents might not have the intention to transmit gendered information, or that gender socialization is expressed in a relatively automatic way (Gawronski et al., 2009). Neurocognitive measures might be better able to capture such subconscious processes than self-report or behavioral measures (Greenwald et al., 2002). In addition, a neuroscientific approach is recommended when examining the intuitive/automatic processes underlying parenting (Parke, 2017). More specifically, neuroscientific research can provide insights in the temporal dynamics underlying parenting as well as the brain areas and processes involved in parenting (Maupin et al., 2015).

Neuroscience might not only add to the understanding of gender socialization, but neurocognitive research on gender socialization could also inform neuroscience, by building a bridge between neuroscientific measures and actual parenting behavior. This could improve the ecological validity of neuroscience (Derks et al., 2013; Feldman, 2015). In addition, neuroscientific research on gender stereotyping has focused primarily on people's responses to unfamiliar adult men and women. It is not yet known whether the same neural processes are also involved when people respond to their own sons and daughters with whom they have a strong emotional connection. Neuroscientific research on gender socialization could answer such questions.

Therefore, this paper reviews what is known about cognitive and neural processes underlying parental gender socialization of children and adolescents, and how these processes can be measured. The goal of this narrative review is not to provide an exhaustive overview of existing research on this topic. Instead, we aim to guide and inspire future research and theory building on the neurocognition of gender socialization, by describing multiple relevant neural and cognitive processes that might be implicated. For some of these processes evidence is already found, but others seem theoretically relevant to study in relation to gender socialization. Throughout this paper the term gender is used to reflect the social meaning attached to a person's biological sex. As the vast majority of research on neurocognitive processes underlying gender socialization takes a binary approach, contrasting males and females, this gender binary is also reflected in the current review. Greater representation of the unique experiences of transgender and nonbinary parents and children remains an important direction for future research on gender socialization.

In this review, we first build on gender schema theories (GSTs; Bem, 1981; Martin & Halverson, 1981; Bem, 1983) and neural models of stereotypes (Amodio, 2014) to identify several neural and cognitive processes that may explain why some parents are more likely to apply gender socialization practices than other parents. Subsequently, empirical evidence for direct associations between cognitive and neural processes and gender socialization is discussed. As this body of literature is small, we will thereafter describe empirical evidence for cognitive and neural processes associated with gendered behavior in general, as these processes might also be implicated in parental gender socialization. We conclude with a summary of the available evidence and directions for future research.

Theoretical underpinnings of cognitive and neural processes in gender socialization

Two theoretical frameworks provide predictions about the neurocognitive processes that might be associated gender socialization, namely gender schema theories and neural models of gender stereotypes.

Gender schema theories

First, from GSTs (Bem, 1981; Martin & Halverson, 1981; Bem, 1983) it can be argued that several cognitive processes might play a role in parents' gender socialization. Gender schemas are cognitive structures containing gender-related information that shape one's processing of the social environment. Although GSTs primarily focus on the link between gender cognitions and gendered behavior and experiences in children, the basic principles can also be applied when trying to explain the mechanisms behind parental gender socialization.

The most relevant prediction from GSTs for explaining parental gender socialization is the idea that gender schemas provide cognitive social standards that guide behavior. Applied to parental gender socialization, this means that parents might use gender socialization to align their children's preferences and behaviors with the culturally determined gender norms or their own gender cognitions. However, there are individual differences in the strength or traditionality of people's gender cognitions (Bem, 1981, 1983). In particular, strong gender cognitions may lead to parental gender socialization that suppresses the child's own interests, skills, and behaviors that do not conform to parents' gender schemas (Bem, 1981, 1983; e.g., suppress doll-play in boys but not in girls). Yet, parents with less strong gender cognitions about boys and girls might be more likely to show egalitarian socialization of their children (e.g., do not treat boys and girls differently, emphasize similarities between boys and girls). GSTs also posit that once gender cognitions become a prescriptive guide, an internalized motivation prompts a person to regulate their behavior (Bem, 1981). This internal motivation encourages a person to regulate their behavior so that it conforms to their gender schemas. In the context of gender socialization, this internalized motivation may entail a parents' motivation for parenting without gender stereotypes.

Several types of interrelated gender cognitions exist that all concern the way people think about themselves and others in terms of gender (Bugental & Johnston, 2000; Tenenbaum & Leaper, 2002). Because gender cognitions are multi-dimensional, this review summarizes evidence for a broad range of gender cognitions. We focus on the following most studied gender cognitions: parents' gender stereotypes and gender attitudes, gendered attributions, gender essentialism, gender identity, internal motivation for parenting without stereotypes, and conflict resolution.

Neural model of implicit stereotypes

In addition, neuroscientists have developed a neural model of implicit stereotypes (Stanley et al., 2008; Amodio, 2014) reflecting several neural processes that could underlie parental gender socialization. In this neural model, the *temporal pole* functions as a hub for social (stereotype) knowledge (Olson et al., 2013). Based on this stereotype knowledge, the *amygdala* automatically evaluates socially salient (both negative and positive) stimuli and facilitates the allocation of the appropriate attentional processes to respond (Amodio, 2014). However, relying solely on automatic evaluations to drive our behaviors is not an optimal strategy in our complex social environment, and a certain level of control over the influence of stereotypes on behavior would be necessary. Therefore, the *anterior cingulate cortex (ACC)* is thought to monitor conflict between the automatic evaluations of a stimulus with the person's expectations of that stimulus. For instance, when a parent expects boys to be tough but encounters a crying boy, conflict arises, which is signaled by the ACC. When conflict arises, the ACC in turn activates the dorsolateral *prefrontal cortex (dlPFC) and dorsomedial prefrontal cortex (dmPFC)* to resolve the conflict (Stanley et al., 2008; Cattaneo et al., 2011). These prefrontal brain structures, together with the striatum and motor cortex, then regulate a person's behavioral responses, allowing one to overcome the expression of gender stereotypes (Cattaneo et al., 2011).

In the context of gender socialization, the amygdala's role in signaling salience may be particularly relevant (Santos et al., 2011). The amygdala might become activated in response to a son or daughter violating gender expectations, as such stereotype violations are salient. Increased salience processing of unexpected behavior might explain parents' negative responses to children's behavior that violates gender expectations (e.g., Sandnabba & Ahlberg, 1999; Endendijk et al., 2014). However, when top-down (ACC and dmPFC/dlPFC) conflict-monitoring and behavior regulatory mechanisms are activated, parents might be able to overcome their first automatic response and inhibit negative responses to boys' and girls' gender-atypical behavior (Li et al., 2016).

Thus, neural models of gender stereotypes point to the following processes as possibly underlying parental gender socialization: parents' gender knowledge (i.e., type of gender cognition), attention allocation processes, conflict resolution mechanisms, and behavioral regulation mechanisms.

Materials and methods

A narrative review was conducted to provide an overview of the available information on cognitive and neural processes that may be underlying gender socialization. A narrative review is different from a systematic review in that it is not aimed to be systematic or exhaustive, but instead provides an overview of the state-of-the-art in a certain field of research. The goal is to guide future theory building and research in the field. As recommended by Lilford et al. (2001), a wide range of databases and sources were used for our literature search. Second, Lilford et al. (2001) have recommended to allow overlap in the stages of the review process, while differentiating the phases of searching, analyzing, and writing up of the review report. This recommendation allows the researchers to refine concepts concerning the nature and scope of the review. These principles were applied in our search strategies for articles to be included in this narrative review.

The following process was used for the literature search. First, terms were identified on the basis of two relevant theoretical models (i.e., the GSTs and the neural model of implicit stereotypes), as well as the authors' expert knowledge of literature on gender socialization. For cognitive processes, search terms included: gender cognitions, (parents) gender stereotypes, (parent) gender attitudes, gendered attributions, gender essentialism, gender identity, and internal motivation to respond without prejudice. For the neural processes, we used neuroscientific measurement terms (electroencephalography, functional MRI, TMS) combined with (gender) stereotypes, (gendered) parenting, or gender socialization. These terms were entered in Google Scholar, Scopus, and Web of Science to search for literature regarding these terms in relation to gender socialization. Moreover, we have used the citation and reference lists of relevant articles to identify research that could be related to our topic. In a second stage, other terms were added to the literature search. For cognitive processes, these terms included intergroup relations, conflict resolution, and (benevolent) sexism. For neural processes, search strategies were broadened to include racial stereotypes and attitudes, as well as the relation between neural processes and parenting in general. This was done to obtain a more comprehensive image of neural processes, since the neuroscientific literature on gender socialization is scarce. The first and last authors together decided on the inclusion and exclusion of articles in the review. The main inclusion criterium was that a type of cognitive or neural process was examined and related to gender socialization, gendered behavior, or (gender) stereotyping.

Empirical evidence for cognitive processes implicated in parental gender socialization

For several cognitive processes proposed by GST's as underlying parents gender socialization direct empirical evidence has been found. This will be discussed separately for the different cognitive processes.

Parental gender stereotypes and attitudes

A stereotype is "the association of a social group with one or more (non-valence) attribute concepts" (Greenwald et al., 2002). Applied to gender, the social categories are men/boys and women/girls, and attribute concepts often relate to the behaviors, roles and characteristics that are typically associated with men or women. A gender attitude refers to people's positive and negative evaluations of the behaviors, roles and characteristics for men and women (Greenwald et al., 2002). Gender stereotypes and attitudes can be present at both an explicit and an implicit level (Gawronski & Creighton, 2013). Explicit stereotypes and attitudes are overtly expressed ideas that are under conscious control and, therefore, are especially prone to social-desirable responding (Greenwald et al., 2009). Implicit stereotypes and attitudes, on the other hand, are supposedly relatively inaccessible to conscious awareness, are elicited unintentionally, require few cognitive resources, and cannot be stopped voluntarily (Gawronski & Bodenhausen, 2006). Implicit stereotypes and attitudes are therefore most often assessed with response latency measures. For such measures is assumed that performing congruent tasks in which responses and stereotypes/attitudes are aligned require less effort and can be performed faster, compared to incongruent tasks reflecting stereotypes/attitudes and responses that do not align.

A widely used response latency measure to assess implicit gender stereotypes and attitudes is the Implicit Association Test (IAT; Rudman et al., 1999; Greenwald & Krieger, 2006). IATs measure the strength of (automatic) cultural associations between concepts (e.g., boys, girls, men, women) and attributes (e.g., male-typed toys, female-typed toys, science, career, family). The validity of the IAT is, although criticized, well-documented (Bluemke & Friese, 2008; Greenwald et al., 2009).

In a study that measured parents' gender stereotypes about career and family with an IAT, fathers with stereotypical IAT scores (i.e., associating career with men and family with women) used more physical control strategies with their 3-year-old sons than with their 3-year-old daughters (Endendijk et al., 2017). On the other hand, fathers with counter-stereotypical IAT scores (i.e., associating career with women and family with men) used more physical control strategies with daughters than with sons (Endendijk et al., 2017). Individual differences in parents' implicit gender stereotypes might thus be related to individual differences in gender-differentiated parenting.

In another study, parents' gender stereotypes about toys were assessed with a task similar to the IAT and gender socialization was captured during picture book reading (Endendijk et al., 2014). Mothers with stronger implicit gender stereotypes were more likely than mothers with more egalitarian stereotypes to employ gendered communication that emphasized gender stereotypes toward their preschool children. More specifically, they made more comments confirming gender stereotypes, they evaluated gender-role inconsistent behavior more negatively, and they used gender labels to convey the stereotype-congruent nature of the activities in the pictures (e.g., using the masculine label for gender-neutral children playing with water guns). Together, these studies provide evidence for the idea that implicit gender stereotypes are a mechanism underlying parents' gender socialization practices.

Even though implicit cognitions are often better predictors of behavior than explicit cognitions (Greenwald et al., 2009), there are several studies that find associations between explicit gender stereotypes or attitudes and parents' gender socialization as well. These studies provide further support for gender stereotypes and attitudes being an important mechanism underlying gender socialization of children and adolescents. For instance, stronger gender stereotypes about toys were associated with less nontraditional toy purchases in prospective parents (Weisgram & Bruun, 2018). Also, mothers who reported having egalitarian gender-role attitudes made more counterstereotypical comments during book reading (e.g., "Girls can also build igloos!") toward their preschool children than mothers who reported more traditional gender-role attitudes (Friedman et al., 2007). In addition, parents with egalitarian gender-role attitudes found cross-gender-typed toys more desirable for their preschool children than did parents with traditional gender-role attitudes (Kollmayer et al., 2018).

In middle childhood, more traditional gender attitudes were associated with a more gender-stereotyped division of labor between parents (i.e., modeling aspect of gender socialization; McHale et al., 1999) as well as with encouragement of gender-typed behaviors in their children (Raffaelli & Ontai, 2004), but children's felt pressure from parents to conform to gender roles appeared unrelated to parents' gender socialization attitudes (Schroeder & Liben, 2021). Also in middle childhood, parents with stronger math-gender stereotypes provided more intrusive support to middle school girls during math homework (Bhanot & Jovanovic, 2005) and were involved in their daughter's math homework (Denner et al., 2016). In adolescence, more traditional gender-role attitudes in mothers were associated with more conservative child rearing practices that taught daughters to comply with traditional norms and values (Ex & Janssens, 1998), as well as with granting girls fewer autonomy opportunities than boys (Bumpus et al., 2001). However, mothers with more traditional gendered beliefs were not found to differentiate between boys and girls.

Parents' gender attributions

Next, to gender stereotypes and attitudes, parents may hold different attributions of the intentions, behaviors, gendered goals, and appropriateness of responses of their sons and daughters (Endendijk et al., 2018b; Bugental & Corpuz, 2019). Gendered attributions are the gender-differentiated inferences and beliefs parents have about the causes of their children's behaviors, achievements, and preferences. Gender attributions differ from gender stereotypes in that they concern the roots of people's achievements and behaviors, rather than the preferences and behaviors itself (Reyna, 2000). Parents' attributions of the behavior of boys and girls can be measured with vignettes, scenarios, or pictures showing boys and girls in different behaviors (Morrongiello & Rennie, 1998; Morrongiello & Hogg, 2004). In a study using a scenarios of risk behavior, parents of preschoolers believed that boys' risky behaviors are inborn, whereas girls' risky behaviors were triggered by situational factors (Morrongiello & Rennie, 1998; Morrongiello et al., 2010). Consistent with these attributions, parents believed that daughters can be taught to comply with safety rules more than sons (Morrongiello et al., 2010), and parents would supervise and actively try to prevent risky misbehavior to daughters, but not to sons in middle childhood (Morrongiello & Hogg, 2004; Morrongiello et al., 2008). Apparently, mothers' gendered attributions about the fixed/malleable nature of boys' or girls' characteristics might explain whether mothers used gender-differentiated parenting practices to prevent risky behavior.

Evidence for cognitive processes that underlie gendered behavior in general

Previous research has established that several types of gender cognitions, such as gender stereotypes and attitudes and parents' gendered attributions were associated with parents' gender-differentiated parenting. It seems plausible that other cognitive processes might also play a role in parental gender socialization. These cognitive processes are, however, hardly studied in the context of gender socialization.

Gender identity

Parents' own gender identity could also play a role in their gender socialization practices. Gender identity refers to one's sense of being male or female and provides an important basis for people's interaction with others (Steensma et al., 2013), and is most often assessed via self-report (e.g., Dinella et al., 2014). In general, gender identity is thought to foster behavior in line with gender roles (Taylor & Hall, 1982). Yet, gender identity might also explain variability in behavior because gender identity differs across individuals (Wood & Eagly, 2015). Applied to gender socialization this could mean that parents who strongly identify with their own gender might socialize their children into traditional gender roles. In adults, gender identity has been associated with several gender-typed behaviors and cognitions (Wood & Eagly, 2015). For instance, feminine gender identity has been associated with greater involvement with family roles (Abele, 2003). In addition, self-perceived gender typicality (one of the dimensions of gender identity) was related to more gender-typical career interests in both men and women (Dinella et al., 2014). It is yet unclear whether gender identity is also associated with other forms of parental gender socialization.

Intergroup attitudes

Intergroup attitudes can be defined as the tendency to evaluate one's own membership group (the in-group) more favorably than a non-membership group (the out-group) (Tajfel & Turner, 1986). Intergroup attitudes can be measured with self-report questionnaires assessing people's evaluation of the in-group and out-group, or with Implicit Association Tests in which participants have to pair positive and negative attributes to the ingroup and outgroup (Greenwald & Pettigrew, 2014). We know that adults implicitly and explicitly evaluate their own gender positively and the other gender more negatively (Rudman & Goodwin, 2004; Dunham et al., 2016), which is associated with discriminative behavior to outgroup members (for a review, see Greenwald & Pettigrew, 2014). However, it is not known whether parents' in-group favoritism also transfers to different treatment of same-gender offspring compared to opposite-gender offspring. There is some evidence in the preschool period that mothers who endorsed hostile sexist attitudes, which might be related to in-group favoritism, had stronger maternal gatekeeping tendencies, which resulted in a greater maternal share of childcare tasks relative to the father (i.e., modeling aspect of gender socialization; Gaunt & Pinho, 2018).

Gender essentialism

Gender essentialism is the idea that "members of a category share an inherent, non-obvious property (essence) that confers identity and causes other category-typical properties to emerge" (Gelman et al., 2004). People with essentialist beliefs consider gender differences to be innate (rather than environmentally evoked) and thus fixed (instead of malleable), and are often more inclined to support gender discriminatory processes and endorse gender inequalities (Skewes et al., 2018). Essentialists beliefs are predictive of gender stereotype endorsement in both non-parents (Bastian & Haslam, 2006) and parents (Meyer & Gelman, 2016). Of interest to the current review was that parents' gender essentialism was associated with young children's gender-typed preferences (Meyer & Gelman, 2016). Parental gender socialization might mediate this association, such that parents with strong essentialist beliefs may reinforce or shape children's behaviors toward more gender-typical preferences (Meyer & Gelman, 2016). However, it is also possible that having children with strong gender-typed preferences might fuel parents' gender essentialist thinking. Essentialist thinking has been associated with a more traditional division of household tasks between parents in families with preschool children (Pinho & Gaunt, 2021). Longitudinal research, examining direct relations between parents' gender essentialism and gender socialization while controlling for children's gender-typed behavior, is necessary to determine whether gender essentialism indeed underlies parental gender socialization.

Conflict resolution

Another relevant cognitive process is conflict resolution. The idea is that when people have to categorize clear, or stereotype-congruent, exemplars of a category (e.g., a masculine boy) they experience less internal conflict than when they have to categorize less clear, or stereotype-incongruent, exemplars of a category (e.g., a feminine boy). Parents might experience conflict when their child shows behavior that is not in line with the stereotyped expectancies they have about the appropriate behavior of boys and girls (Endendijk et al., 2019b). When they are unable to resolve this internal conflict, they might use gender socialization practices aimed at aligning the behavior of their child with their stereotyped expectancies, and thus restore conflict.

Conflict resolution can be captured with the use of mouse-tracking paradigms. In general, mouse-tracking paradigms require people to categorize (visual) stimuli onto two categories presented in the left and right corners of a screen. The trajectory they make with the mouse when dragging a stimulus to one of the categories is captured. When the trajectory deviates from a straight line between the stimulus and the category this provides indications of response conflict, as well as whether decisions are made relatively automatically and then consciously confirmed or overridden (Stillman et al., 2018).

Mouse-tracking has not been used yet to explain parents' gender socialization practices. But there is some evidence that mouse-tracking trajectories indeed are associated with actual gendered behavior in non-parents (Hehman et al., 2014a). Hehman et al. (2014a) examined whether gendered facial attributes of U.S. female politicians were associated with the likelihood of being voted for during elections. They found that when female politicians' faces were more gender-incongruent, participants experienced more conflict assigning the face to the female category, as evidenced by a larger slope in the observed mouse trajectory. In addition, participants were less likely to vote for these female politicians, but this was not the case for male politicians. Moreover, this effect was even more pronounced in more conservative areas in the U.S. (Hehman et al., 2014a).Motivation for parenting without gender stereotypes

Parents' motivation for parenting without gender stereotypes forms another relevant factor to study in relation to gender socialization. One's motivation to respond without prejudice or bias is theorized to function as a buffer for expressing stereotypes or behaving in accordance with stereotypes (Plant & Devine, 1998). This motivation can be both internal and external. External motivation depends on social pressure to inhibit the overt expression of stereotypes. Internal motivation represents underlying, intrinsic motivations to respond without prejudice irrespective of the situational pressures. It might be most relevant to relate parents' internal motivation to their implicit gender socialization practices since gender socialization frequently takes place when parents are at home with their children. In this context social pressures are unlikely to play a role. Parents with higher internal motivation for parenting without gender stereotypes might be less likely to use gender socialization that steers boys and girls into traditional gender roles (Plant & Devine, 1998).

Evidence exists that internal motivation to respond without stereotypes contributes to less stereotyped behavior in two ways (Amodio & Swencionis, 2018). First, internal motivation can suppress the activation of stereotypes, for instance when a parent's son wants to play with dolls. This process is found to be preconscious and might prevent the activation of the stereotype 'boys do not play with dolls' (Amodio et al., 2008) and subsequently prevent a parent's negative response to the gender-atypical behavior of their son. However, it might not always be possible to completely avoid the activation of gender stereotypes because of external influences (e.g., children making stereotyped comments) or internal influences (e.g., cognitive overload; Amodio & Swencionis, 2018). Once stereotypes do get activated, internal motivation can also support the intentional control of gender stereotypes over behavior. In the context of gender socialization this could mean that when parents hold stereotyped expectancies about the behavior of boys and girls, these stereotypes could get activated by the behavior of their sons and daughters. However, when parents have a strong internal motivation for parenting without gender stereotypes this motivation might suppress the influence of gender stereotypes on their parenting behavior. Although there is ample evidence that internal motivation to respond without prejudice is related to less stereotyped behavior in interracial relations (Butz & Plant, 2009), this has not been examined in the gender socialization context. In order to study this factor in a gender socialization context some adaptation might be needed, for instance by conceptualizing it as parents' motivation for parenting without gender stereotypes. A recent study in parents found that mothers' internal motivation to behave without gender stereotypes appeared unrelated to how mothers' evaluated preschool boys' and girls' stereotypical and counter-stereotypical toy play (Endendijk et al., 2019a). However, both the internal motivation measure as well as the toy-play evaluation measure concerned boys and girls in general, and not mothers' own sons and daughters (Endendijk et al., 2019a). It may be more relevant to measure if parents' internal motivations for parenting without gender stereotypes is related to gender socialization practices with their sons and daughters.

Domain-specificity of gender cognitions

Studies linking parental gender cognitions to gender socialization practices thus far have focused primarily on parents' stereotyped expectancies and attitudes about boys' and girls' toy and activity preferences and academic abilities. However, gender cognitions can span multiple domains, which might be specifically linked to different types of gender socialization. For example, parents gender stereotypes about toys and activities might be specifically related to the toys that parents provide their children with and the activities they involve their children in. However, adults also hold different explicit expectations about children's personality traits and behaviors (Martin, 1995). For instance, they rate some emotions and behaviors, such as crying, being easily frightened, to be less desirable for boys, and other behaviors, such as being noisy, as less desirable for girls (Martin, 1995). These expectations about the appropriateness of certain *emotions and behaviors* for boys and girls might specifically explain whether parents socialize girls and boys to show different *emotions* (Fivush et al., 2000; Chaplin et al., 2005; van der Pol et al., 2015) or to exhibit different *behaviors* (Endendijk et al., 2017). Together, these studies highlight the importance of examining associations between parents' gender cognitions and gender socialization practices in a domain-specific way.

Empirical evidence for neural processes associated with parental gender socialization

Researchers have used both functional magnetic resonance imaging (fMRI) and electroencephalography (EEG) to identify the neural correlates of gender socialization. Each measure has its own advantages. Functional imaging studies have the benefits of a high spatial resolution, meaning that they are better at localizing activity in certain brain areas. EEG, on the other hand, provides a high temporal resolution, which enables researchers to capture the implicit nature and temporal dynamics of parenting (Maupin et al., 2015). Summarizing the findings of both methods will provide a completer and more detailed image of neural processes underlying parental gender socialization. There are only a handful studies that assessed the neural processing of gendered stimuli, and even fewer studies who examined this in parents. Therefore, we also present evidence in non-parents for the neural networks and processes associated with stereotypes and stereotyped responses in general in the next section.

People's neural responses to stimuli that violated social expectations have generally been studied using three paradigms. First, several studies have used Implicit Association Tests (e.g., Healy et al., 2015). These studies examined whether neural responses differed between trials in which words/pictures had to be categorized in a way that was consistent with social expectations and trials in which words/pictures had to be categorized in a way that violated social expectations. Second, other studies used passive viewing paradigms (e.g., Endendijk et al., 2019a). In such paradigms, participants were asked to look and form impressions of pictures showing people violating social expectations or people confirming social expectations. Differences in brain activity between the two types of pictures were examined. Third, studies have used priming paradigms (e.g., Hehman et al., 2014c). For example, participants were shown pictures of men or women that were primed with words that either violated or confirmed social expectations. Participants had to categorize the pictures as male or female. Brain activity was compared between the trials that violated versus confirmed social expectations. These tasks are similar to the tasks used to assess parents' gender stereotypes and attitudes that were discussed in the section on cognitive processes.

Studies using EEG to examine neural correlates of gender stereotypes and stereotyped behavior are often designed to capture event-related potentials (ERPs). ERPs are epochs of neural activity that are time-locked to the presentation of a stimulus and measured by electrodes. It is somewhat speculative to which neural processes ERPs refer, but studies over the years have associated such event-related activity to several functions in the brain.

The one study that specifically related ERPs elicited by gender-congruent versus incongruent stimuli to mothers' gender communication with their own children found evidence for the importance of early attentional processing in gender socialization (Endendijk et al., 2019b). Differences in P300 and N2 activity between gender-congruent (e.g., associating a toy car with a boy) and incongruent (e.g., associating a doll with a boy) stimuli were found to be related to the mothers' gendered communication with their preschool children (Endendijk et al., 2019b). N2 activity reflects overcoming stereotypical responses (i.e., *conflict resolution*) or *conflict monitoring* (Azizian et al., 2006). The P300 is thought to reflect processes such as *response selection* under difficult conditions (Twomey et al., 2015) and *attention allocation* to stimuli that are negatively valenced, surprising, or unexpected (Bartholow & Dickter, 2007; Polich, 2007). In addition, these differences in early neural processing were more robustly related to gendered communication than their level of implicit or explicit gender stereotypes (Endendijk et al., 2019b). Together, these findings demonstrated that gendered communication is indeed an unconscious process.

In addition, parents' attention allocation to gendered stimuli, more specifically attention to unexpected gender stimuli and attention to gender stimuli that parents evaluated as positive, might underlie gendered communication.

One functional magnetic resonance imaging (fMRI) study in fathers also provides evidence for the assumption that neural responses to gender stimuli are associated with real-world parenting behaviors. In this study, fathers of daughters were more attentively engaged, sang more, and used more analytical language and language related to sadness and the body with their daughters, than fathers of sons (Mascaro et al., 2017). In contrast, fathers of sons spend more time in rough and tumble play (RTP) and used more achievement language with their sons than did fathers of daughters. Additionally, fathers of daughters showed elevated medial and lateral OFC (mOFC and lOFC) responses toward their daughters' happy facial expression, whereas fathers of sons showed elevated mOFC responsivity toward their sons' neutral facial expressions. More importantly, mOFC activity in response to happy facial expressions was negatively associated with the amount of time fathers engaged in RTP, whereas the mOFC responsivity toward neutral faces was positively associated with more time spend in RTP for fathers of sons specifically (Mascaro et al., 2017). The mOFC has been implicated in reward processing (Rolls et al., 2020). Hence, parents' *reward processing* of the emotional faces of their sons and daughters might underlie differences in play styles with their sons and daughters.

Evidence for neural processes underlying (gender) stereotyping in general

EEG research

Research on people's temporal processes toward the violation of social expectations have pointed toward several other ERPs than the previously mentioned N2 and P3 that might be relevant in the context of gender socialization. The first are *early attentional processes* reflected by peak P100, N170, and P200 amplitude. The P100, N170 and P200 ERPs were found to be elicited by out-group faces during an IAT (He et al., 2009) and by behaviors violating expectations during an impression formation task (Dickter & Gyurovski, 2012; Rodríguez-Gómez et al., 2020). Second, the late positive potential (LPP) which reflects *attentional orienting* to salient stimuli (Huffmeijer et al., 2014).

EEG studies on the neural correlates of gender stereotypes in (non-)parents have found several indications of altered early-stage processing in occipital and frontal lobes that were associated with different types of (gender) cognitions. For example, Healy et al. (2015) found larger N2 amplitudes during congruent trials than incongruent trials, specifically in people with medium stereotype scores. Regarding the P200, people with stronger racial biases demonstrated greater P200 activity to incongruent racial stimuli (e.g., black face primed with white trait) than to congruent racial stimuli (e.g., black face primed with black trait; Hehman et al., 2014c). Regarding the LPP, differences in LPP activity to gender-stereotype congruent and incongruent sentences were associated with adults' hostile sexism (Canal et al., 2015). However, differences in N170 and LPP to gender congruent and incongruent sentence-face combinations were found to be unrelated to adults' level of sexism (Rodríguez-Gómez et al., 2020). Together these studies indicate that *early attentional processing* of stimuli that confirm of violate stereotyped expectations and salience processing might underlie stereotypes and stereotyped behavior in general.

Although limited, there are some studies that have implicated brain activity epochs and activation patterns with actual behaviors. For example, one study associated N2 amplitude differences in fronto-central areas during a prosocial attitude IAT with actual donating behaviors (Xiao et al., 2015). The researchers found that people who showed increased N2 activity in response to incongruent trials (associating prosocial words with "others" and non-prosocial words with "self") on the prosocial IAT, donated more than people who showed increased N2 activity in response to congruent trials (associating prosocial words with "self" and non-prosocial words with "others"). The increased N2 activity found in this study might reflect increased attention to stimuli that fit with peoples' prosocial (or self-oriented) behavioral tendencies.

fMRI research

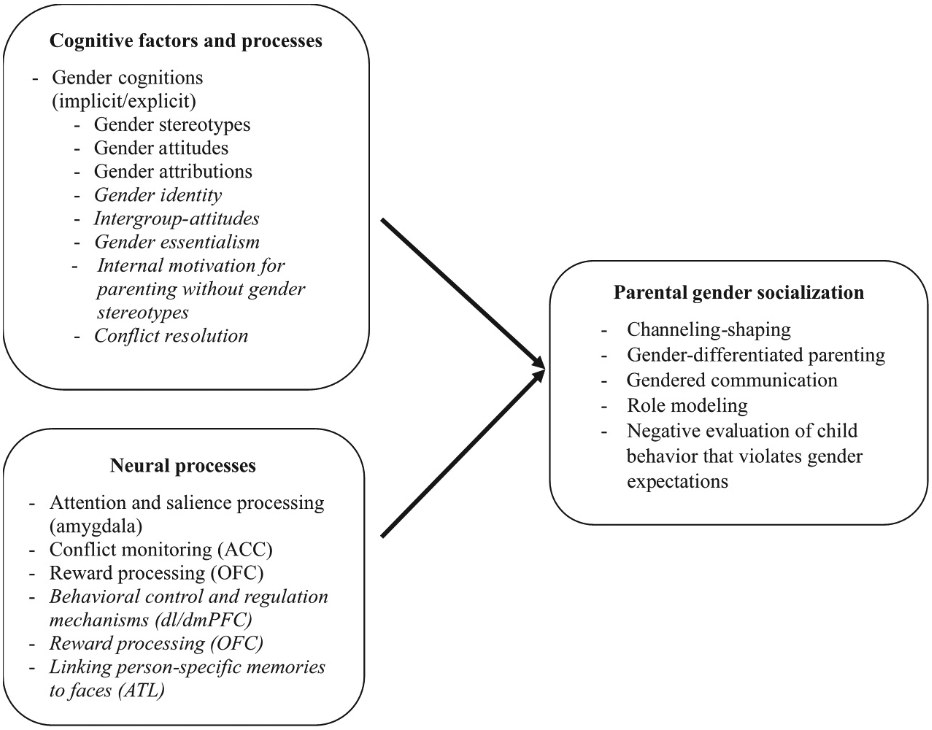
Research on the neural activation patterns of adults when they had to categorize stimuli that confirm or violate stereotypical expectations have shown elevated neural activation in behavioral regulation networks (Knutson et al., 2007; Mitchell, 2008; Quadflieg et al., 2011). For instance, when non-parents categorized targets that were inconsistent with their gender-stereotypes, the *dmPFC*, middle temporal gyrus and the posterior cingulate cortex showed enhanced activation (Quadflieg et al., 2011). *Medial PFC and ACC* regions were also activated while non-parents had to categorize stereotype-congruent gender and race stimuli, whereas the *dlPFC* was recruited when participants were asked to categorize stimuli that were incongruent with their stereotypes (Knutson et al., 2007). Importantly, activation of the *dlPFC* in response to stereotype violating stimuli was associated with the strength of people's stereotypes (Hehman et al., 2014b). Activation of the *dmPFC* cortex was found in response to stereotype violating racial stimuli, but a stronger internal motivation to respond without prejudice attenuated the dmPFC response (Li et al., 2016). In addition, enhanced *amygdala* activation was found during gender-congruent trials (Knutson et al., 2007). Activity in the *anterior temporal lobe* (*ATL*; part of the temporal pole) has also been associated with both implicit racial stereotypes and attitudes assessed with IATs (Gilbert et al., 2012). However, it is unclear whether the ATL might also play a role in both the evaluative component (i.e., attitudes) and the associative component (i.e., stereotyping) of parents' gender cognitions (Gilbert et al., 2012). The temporal pole is presumed to be critical for *linking person-specific memories to faces* (Olson et al., 2013) and might therefore also play a role in the memories of gender-typical and atypical behavior that parents link to their child's face.

When examining the neural processing of gender stereotypes in mothers of young children, both the *dmPFC and the ACC* have shown larger BOLD changes pictures of children combined with stereotype-incongruent toy words (Endendijk et al., 2019a). The elevated ACC activity was also associated with stronger gender stereotypes in mothers, most likely reflecting the ACC's role in conflict monitoring. Additionally, in mothers, the left temporoparietal junction (TPJ) responded specifically when incongruent toy words were paired with boy faces (Endendijk et al., 2019a). The larger TPJ activation may reflect the more restrictive gender norms for boys (Sandnabba & Ahlberg, 1999; Kane, 2006), since the TPJ is often activated when social expectations are violated (Cloutier et al., 2011). These results indicate that mothers might *experience conflict* when a child's behavior does not match their gender stereotypical expectations, but how this transfers to actual gender socialization practices with their own children is largely unknown.

Summary of findings and future directions

In sum, there are several cognitive and neural factors that (potentially) play a role in explaining why there is variation between parents in the degree to which they employ gender socialization with their children. The findings are summarized in Figure 2.1, which visualizes the neural and cognitive factors that were either theoretically or empirically related to parental gender socialization in our synthesis of the literature. In the following paragraphs, these findings are summarized, followed by description of limitations. This section concludes with several recommendations for future research and the social and practical implications of this review.

Figure 2.1. Overview of neural and cognitive processes underlying parental gender socialization.



Note. Cognitive and neural processes written in italics are processes for which there is only theoretical support and/or indirect empirical evidence linking these processes to other types of stereotyped behavior than gender socialization. For processes and factor that are not in italics, there is direct evidence of a link with parental gender socialization. The following abbreviations are used in the model: anterior cingulate cortex (ACC), dorsolateral and dorsomedial prefrontal cortex (dl/dmPFC), orbitofrontal cortex (OFC), anterior temporal pole (ATL).

First, to summarize the cognitive processes, evidence exists that parents' gender stereotypes and attitudes are implicated in different aspects of gender socialization of children as well as adolescents. There is also some evidence for a link between parents' gender attributions of the behavior of boys and girls and parents' differential treatment of boys and girls. For other cognitive factors, such as internal motivation for parenting without gender stereotypes, gender identity, conflict resolution, and intergroup attitudes, theoretical grounding can be provided that these factors might underlie gender socialization. Moreover, gender stereotypes about other domains than toys, gender roles, and academic achievements are likely to play a role in the ways in which parents apply gender socialization. Additional evidence shows that these gender cognitions are implicated in other forms of stereotyped behavior than gender socialization, such as discriminative behavior toward other-gender or other-race individuals, involvement with family roles, or gender-biased voting. Yet, more empirical evidence is necessary to support the association between these cognitive processes and specific gender socialization domains (e.g., role modeling or creating a gendered environment for children).

Second, regarding the neural processes, neural networks associated with attention allocation, salience processing, conflict monitoring, and reward processing, are activated in parents when they are exposed to gendered child stimuli, and this neural processing was associated with the gender socialization they employed with parents' own children. There is also evidence from several studies in non-parents that brain areas associated with attention allocation and salience processing (amygdala, TPJ), conflict monitoring (ACC), behavior regulation (dl/dmPFC), and linking person-specific memories to faces (ATL) are implicated in people's stereotypes and stereotyped responses. However, more research in parents with both boys and girls is necessary to further substantiate the link between the above-mentioned neural processes and actual gender socialization practices with parents' own children.

Limitations

The current review summarized several cognitive and neural processes that are theoretically or empirically related to parental gender socialization. However, some caveats must be mentioned. First, it is important to note that there is still little research investigating the neural and cognitive processes that may be underlying parental gender socialization. Moreover, for many included studies, the main aim was not to examine the neural or cognitive processes underlying gender socialization and these associations were often part of descriptive or additional analyses.

Furthermore, many studies that have informed the neural network of stereotypes have examined the neural processing of racial stereotypes. However, some precautions must be made before generalizing results from studies on racial stereotypes to gender stereotypes and gender socialization. Racial studies have often examined the neural correlates of race bias under the assumption that people react differently to in-group than to out-group members. However, in-group biases in men and women do not necessarily correlate with their gender expectations (Rudman & Goodwin, 2004). The neural processes implicated in racial stereotypes need to be further evaluated, to see if these processes are also implicated in the context of gender socialization. There is also a general note of caution for interpreting EEG and fMRI studies, because of the often small sample sizes and contradictory findings. Therefore, future research with larger sample sizes is necessary to investigate the neural processes underlying parental gender socialization in the home context.

In addition, the current overview focuses on parents' gender socialization with their children across childhood and adolescence, but the number of studies that focused on the correlates of parental gender socialization during adolescence was limited. It seems likely that different types of gender socialization (e.g., sexuality, autonomy) are more relevant during teenage years than during early childhood. More research on the processes underlying parents' gender socialization during adolescence is needed to examine whether additional mechanisms emerge during parental gender socialization with adolescents.

Moreover, the studies described in this paper examined predictors of gender socialization in primarily heterosexual and cisgender parents and toward cisgender children. Even though there is evidence that LGBTQ+ parents are more similar than different than heterosexual parents in their gender socialization practices (Averett, 2016; Bergstrom-Lynch, 2020), it is still important for future research to investigate whether similar neurocognitive processes underlie gender socialization in LGBTQ+ parents and nonbinary or transgender children. For example, the relative importance and strength of association with each neurocognitive process might be different. LGBTQ+ parents might have less strong gender stereotypes through their own gender nonconforming preferences and behaviors and therefore serve as more diverse gender role models for their children (Averett, 2016; Kuvalanka et al., 2018). Similarly, because of their gender nonconforming identity, LGBTQ+ parents might be more motivated to parent without stereotypes, allowing parents to overcome their own gendered beliefs of how a girl or a boy should behave.

Finally, the current overview mainly includes studies with non-Hispanic White US and European families, with the exemption of two studies conducted among Latinx families. However, culture also influences parents' gender socialization, since it prescribes the gender norms that are ascribed to each gender. For example, Mexican American parents with stronger orientations toward traditional Mexican culture were more likely than parents oriented toward American culture to treat their sons and daughters differently (McHale et al., 2005). The processes presented in the current overview should also be examined in other cultural populations, to examine whether the mechanisms proposed in this study can be generalized toward other non-Western populations. Relatedly, as many other factors interact with gender, such as socioeconomic status, ethnicity, or social class, future research on the processes underlying gender socialization should take a more intersectional approach. Such research could for instance examine differences in the relative importance of each neurocognitive process for parental gender socialization at the intersection of gender and ethnicity, or at the intersection of ethnicity and socioeconomic status.

Recommendations for future research

Thus far, very few studies have associated gender cognitions and neural processes with gender socialization. Understanding determinants for parent's engagement in gender socialization is important, as these determinants can be targeted in interventions to reduce traditional gender socialization or foster more gender-neutral socialization (Kok et al., 2016). Therefore, more empirical research is necessary to validate the relevance of the neural and cognitive factors identified in this review for gender socialization across childhood and adolescence. In general, parental gender socialization research could benefit from studies that examine the contributions of several gender cognitions, such as gender identity, gender attributions, and intergroup attitudes on parents' gender-differentiated parenting with a multi-method approach including observations, self-report questionnaires and/or IATs. Table 2.1 provides an overview of measures that can be used to assess these cognitive and neural processes in future research.

Studies that focus on the role of internal motivation for parenting without gender stereotypes could additionally investigate the direct and potential moderating role of internal motivation on parents' gender socialization practices. For example, if parents are aware of the implicit nature in which they steer their sons and daughters into traditional gender-roles, they may be more hesitant to employ these parenting strategies. As a result, parents may be more attentive of their gender socialization practices and increase their motivation to refrain from employing parental gender socialization strategies.

Table 2.1. Methods to assess neurocognitive processes underlying parental implicit gender socialization.

	Methods
<u>Cognitive processes</u>	
Gender stereotypes and attitudes	Implicit Association Tests (e.g., Endendijk et al., 2017) Self-report questionnaires (e.g., Friedman et al., 2007)
Internal motivation for parenting without gender stereotypes	Self-report questionnaire assessing internal motivation regarding parenting own son(s) and/or daughter(s) (e.g., Endendijk et al., 2019a)
Conflict resolution	Mouse-tracking paradigm (e.g., Hehman et al., 2014a)
Gender attributions	Scenarios, vignettes, pictures (e.g., Morrongiello & Hogg, 2004)
Gender identity	Self-report questionnaire (e.g., Dinella et al., 2014)
Intergroup attitudes	Implicit Association Tasks (e.g., Rudman & Goodwin, 2004) Self-reported evaluations of gender ingroup and outgroup (e.g., Rudman & Goodwin, 2004)
<u>Neural processes</u>	
	EEG, fMRI, together with: - Passive viewing paradigm (e.g., Endendijk et al., 2019a) - Priming task (e.g., Hehman et al., 2014c) - Implicit Association Task (e.g., Healy et al., 2015)

With regard to the neural processes, Mascaro et al.'s (2017) study provided the first evidence of associations between neural responses to stimuli of parents' own children and differences in play styles with sons and daughters. However, this study examined gender differences in neural responses and play style by comparing fathers of sons with fathers of daughters. Therefore, the authors were unable to directly relate a difference in neural responses to gendered stimuli of sons versus daughters to a difference in gender socialization with sons versus daughters. In order to test such a direct relation, a within-family design is necessary including parents who have both a son and a daughter. Within-family designs are also essential to make sure that differences found in neural and observational responses to boys and girls are not caused by other factors than child gender (McHale et al., 2003; Endendijk et al., 2018b).

Lastly, based on the available research, it seems likely that individual differences in the neural processing of stimuli that violate versus confirm gendered expectations are related to individual differences in gender socialization practices. It is therefore recommended that future studies examine whether individual differences in neural responsivity are related to parents' gender socialization practices with their sons and daughters by combining neuroscientific measures with observational data.

Social and practical implications

The research findings that were highlighted in this paper have several social and practical implications. First, it stresses the need to examine why some parents are more or less likely to employ gender socialization practices than others. Moreover, several factors that are highlighted in this study might provide useful targets for parenting interventions or psycho-education aimed at increasing gender equality in future generations. Parents' internal motivation to parent without gender stereotypes might be the most promising factor for intervention as internal motivation to behave non-prejudiced has been found to suppress both the activation of stereotypes as well as the influence of stereotypes on one's behavior. Similarly, targeting essentialists beliefs about gender in interventions could decrease negative reactions toward (parents of) gender-nonconforming children (Skewes et al., 2018; Sullivan et al., 2018). More gender equal upbringing would decrease the limitations children experience with regard to toy preferences, activities, occupations, and friendship opportunities (Updegraff et al., 1996; Martin et al., 2017; Endendijk & Portengen, 2021).

Conclusion

To conclude, we have indicated several cognitive and neural factors and processes that could explain why parents differ in the extent to which they employ parental gender socialization. In addition, we provided several suggestions for future research methods that can be used to study these neurocognitive processes and factors. The field particularly needs more research that relates parental cognitive factors, such as internal motivation, conflict resolution, gender identity, and intergroup attitudes, and neural processes, such as behavioral control and reward processing, to different types of gender socialization. This overview of neurocognitive processes associated with parental (implicit) gender socialization, and the predictions that originate from this model, aim to spark and inspire future research in this domain.

3

Measuring the neural correlates of the violation of social expectations: A comparison of two experimental tasks

Christel M. Portengen[a], Rens Huffmeijer[b], Anneloes L. van Baar[a], & Joyce J. Endendijk[a]
[a] Clinical Child and Family Studies, Utrecht University, the Netherlands.
[b] Institute of Education and Child Studies, Leiden University, the Netherlands.

This chapter is published as: Portengen, C. M., Huffmeijer, R., Van Baar, A. L., & Endendijk, J. J. (2022). Measuring the neural correlates of the violation of social expectations: A comparison of two experimental tasks. *Social Neuroscience, 17*(1), 58-72. https://doi.org/10.1080/17470919.2022.2032327

Abstract

Evidence exists that people's brains respond differently to stimuli that violate social expectations. However, there are inconsistencies between studies in the event-related potentials (ERP) on which differential brain responses are found, as well as in the direction of the differences. Therefore, the current paper examined which of the two most frequently used tasks, the Impression Formation Task (IFT) or Implicit Association Test (IAT), provided more robust ERP components in response to the violation of gendered expectations. Both IFT and IAT paradigms were administered in a counter-balanced way among 25 young adults (age 22–31, 56% male), while brain activity was assessed with electroencephalography. The IFT and IAT specifically measured the violation of gendered expectations with regard to toy preferences and behavioral tendencies of young children. The results showed that both tasks were able to elicit relevant ERP components. Yet, the IFT evoked ERP effects of the violation of gendered expectations on all but one of the selected ERP components; the P1, N1, and LPP. The IAT only elicited different P3 amplitudes when expectations were violated. We recommend the use of IFT paradigms when studying neural processes underlying the violation of social expectations.

Introduction

A large body of literature demonstrates that people respond negatively to violations of social expectations (Endendijk et al., 2014; Friedman et al., 2007; Kane, 2006; Sandnabba & Ahlberg, 1999). This also holds for gendered expectations. For instance, parents believe that children who do not adhere to traditional gendered expectations, will be less psychologically well-adjusted than "typical" boys and girls later in life (Sandnabba & Ahlberg, 1999). Parents are also more likely to make negative evaluative comments about children's behavior that violates gendered expectations (e.g., "Boys don't play with dolls!"; Endendijk et al., 2014; Friedman et al., 2007). Not only parents, but also non-parental adults rate children who violate gendered expectations as less likeable (Sullivan et al., 2018). Moreover, women who have a successful career in traditionally male-dominated work environments, are perceived as more hostile and less likeable, which affects their overall performance ratings, salary, and job opportunities (Heilman et al., 2004). To understand why negative responses to violations of social expectations with regard to gender, race, or even age, occur, neuroscientists have tried to uncover how the human brain processes the violation of social expectations.

To examine the neural processes underlying peoples' negative reactions to violations of social expectations, researchers often relied on one of the following experimental paradigms: The Implicit Association Test (IAT) and the Impression Formation Task (IFT). Previous research demonstrated that both paradigms are able to elicit meaningful event-related potentials (ERPs), which are time-locked epochs of neural activation patterns that occur around the presentation of a stimulus that violates or confirms social expectations (Dickter & Gyurovski, 2012; Forbes et al., 2012; He et al., 2009; Healy et al., 2015; Hehman et al., 2014c; Li et al., 2016; Williams & Themanson, 2011; Xiao et al., 2015). However, studies differ in the ERP components on which differential brain responses are found. In addition, the reasons for choosing one paradigm over the other are often not explicitly stated in previous studies. These issues might be attributed to the fact that we do not yet know which paradigm is better suited to capture processing of violations of social expectations. Therefore, the current study examines which experimental paradigm, the IAT or the IFT, elicits the most robust pattern of ERPs. We will study this in the context of people's brain responses to violations of gender expectations, since gender is one of the most salient social categories that people use to categorize preferences, occupations, and behaviors from birth onwards (Blakemore et al., 2008).

Both the IAT and the IFT are established tasks to measure responses to violations of social expectations in several domains. The IAT is a response latency task in which participants are asked to divide attributes (science, career, family, caring, male-typed toys, female-typed toys, male, female, boys, girls) across two categories (Greenwald et al., 2003, 2009). The task consists of two blocks that are congruent with social expectations, meaning that the attributes must be assigned to a category that confirms the culturally prescribed social expectations (e.g., "science" and "male" both have to be assigned to the same category). In addition, there are two incongruent blocks, in which attributes must be assigned to a category that violates social expectations (e.g., "family" and "male" have to be assigned to the same category). The IFT, on the other hand, generally requires less active participation of the participants, as they are asked to form impressions of people based on combinations of stimuli that either confirm social expectations (e.g., a picture of a boy with the word "soccer") or violate expectations (e.g., a picture of a boy paired with the word "doll"; Li et al., 2016). In both tasks, brain activity can be compared between trials that confirm social expectations and trials that violate social expectations.

Although both tasks have been shown to elicit meaningful ERPs when they are administered while participants' brain activity is recorded with electroencephalography (EEG), both tasks also come with their own caveats. First, the IAT is known to elicit preparatory brain activity due to the block design in which congruent and incongruent trials are separated. Due to this block design, participants are aware of the upcoming violation of social expectations in the incongruent blocks and confirmation of social expectations in the congruent blocks. This awareness has led to systematic (preparatory) differences in pre-stimulus baseline brain activity between congruent and incongruent trials in previous studies (Bidet-Caulet et al., 2012; Endendijk et al., 2019b; Healy et al., 2015). To correct for these systematic differences in pre-stimulus baseline brain activity, preprocessing of the EEG data needs to be adjusted. This adjusted preprocessing can result in reduced power, or in lower EEG frequencies being filtered out, making especially late-ERP components less reliable (Demiralp et al., 2001). Nonetheless, in previous EEG research using the IAT several relevant ERP components were elicited that were related to behavioral assessments of stereotypes or stereotyped behavior (e.g., Endendijk et al., 2019b; Forbes et al., 2012; Healy et al., 2015).

In the IFT, the IAT-specific issue regarding preparatory brain activity does not occur, since congruent and incongruent trials are presented randomly throughout each block. However, only passively viewing combinations of stimuli may lead to reduced attention to the task in participants. Especially with the large number of trials needed for EEG data, participants may lose their focus after a while in a passive viewing paradigm such as the IFT. To counteract the expected loss of focus, participants are often instructed to evaluate the stimuli by pressing a button. It, however, remains important to take these limitations into account when using the IFT in an EEG study on violations of social expectations.

The ERP components that are most often studied in the context of violations to social expectations are the P1 (He et al., 2009; Liu et al., 2017), N1 (Dickter & Gyurovski, 2012; Healy et al., 2015), P2 (Dickter & Gyurovski, 2012; He et al., 2009; Healy et al., 2015; Jerónimo et al., 2017; Yang et al., 2020), N2/Medial Frontal Negativity (MFN; Dickter & Gyurovski, 2012; Healy et al., 2015; Hilgard et al., 2014), P3 (Fabre et al., 2015; Healy et al., 2015; Siyanova-Chanturia et al., 2012), N400 (Proverbio et al., 2018, 2017; Siyanova-Chanturia et al., 2012; White et al., 2009; Yang et al., 2020; Yao & Wang, 2014), and Late Positive Potential (LPP; Liu et al., 2017; Osterhout et al., 1997; Rodríguez-Gómez et al., 2020; White et al., 2009; Yao & Wang, 2014). The first three ERP components (P1, N1, P2) have been associated with attentional processes; specifically with early and later stages of visual processing (P1, P2; Luck, 2014), and with visual discrimination processes (N1; Luck et al., 2000; Vogel & Luck, 2000). Regarding expectancy violations, female faces with an angry facial expression (i.e., expectation-incongruent) have been found to elicit higher P1 amplitudes than female faces with a happy facial expression (i.e., expectation-congruent) (assessed with a gender categorization task; Liu et al., 2017). The N1 has been found to show larger peaks during expectancy-violating than expectancy-confirming trials during a racial IFT (Dickter & Gyurovski, 2012) but not during an IAT measurement of stereotype violations (Healy et al., 2015). P2 amplitudes were found to be larger when a positive impression of a person is violated by presenting negative behaviors than when a negative impression of an individual is confirmed (assessed with an IFT; Jerónimo et al., 2017). Yet, P2 has also been found to be smaller when stereotypes about lower-status social groups (e.g., homeless people, drug addicts) are violated than when stereotypes are confirmed (assessed with IFT; Yang et al., 2020).

N2 amplitudes (or medial frontal negativity) are often associated with conflict monitoring or overcoming one's stereotyped responses in expectancy violation paradigms (Azizian et al., 2006). Expectancy violating racial stimuli yielded greater N2 amplitudes than expectancy-confirming racial stimuli during an IFT (Dickter & Gyurovski, 2012). In contrast, using an IAT, Healy et al. (2015) found increased N2 activity during stereotype-

3

confirming trials compared to stereotype-violating trails, specifically when participants held medium stereotyped scores.

The P3 latency has been associated with attention to unexpected events (Polich, 2007). Not surprisingly, expectancy-violating stimuli have been found to elicit a larger P3 than expectancy-confirming stimuli in an IFT (Bartholow & Dickter, 2007). The N400 is thought to reflect the cognitive effort needed to integrate a stimulus into a given context, with larger peaks during expectancy-violating trials (e.g., "Women" followed by "Aggressive") compared to expectancy-confirming trials (e.g., "Women" followed by "Nurturing") during IFT paradigms (Proverbio et al., 2017; White et al., 2009; Yang et al., 2020). Finally, the LPP is elicited during tasks in which emotional stimuli are presented and shows a larger amplitude when these stimuli are more salient, for instance, when two stimuli of different modalities (e.g., pictures and words) but with similar valence (i.e., congruent) are combined (Spreckelmeyer et al., 2006). LPP was larger in response to sentences that violated gender expectations (i.e., "the doctor prepared herself for the operation") than to sentences that confirmed gender expectancies (i.e., "the doctor prepared himself for the operation"; Osterhout et al., 1997). On the other hand, angry male facial expressions (i.e., expectancy-confirming) elicited higher LPP amplitudes than happy male faces (i.e., expectancy-violating; Liu et al., 2017).

To summarize, both the violation and confirmation of expectations have evoked ERP components relevant for attentional processing, conflict monitoring, attention to unexpected events, stimulus-context integration, and evaluation of salience. However, there are differences between studies in the ERP components that are elicited by expectancy-violating versus expectancy-confirming stimuli, as well as in the direction of effects that is found (i.e., whether expectancy-violating stimuli elicit larger ERPs than expectancy-confirming stimuli, or the other way around). These between-study differences might be attributed to the different methods (IAT, IFT, categorization paradigm, sentences, words, pictures) that are applied in EEG studies.

In addition, individual differences in the way people process stimuli that violate or confirm social expectations may play a role in whether expectancy-violating or expectancy-confirming stimuli elicit larger ERP amplitudes (Canal et al., 2015; Endendijk et al., 2019b; Healy et al., 2015). For example, a person who strongly expects women to be emotional and men to be stoic, might react differently (on a behavioral and neural level) to a crying man than a person who expects men and women to be equally emotional. Therefore, it is important to consider people's stereotyped expectations and attitudes when examining neural responses to stimuli that violate social expectations. For instance, a study by Endendijk et al. (2019b) demonstrated that P3 and N2 activity elicited by stereotype-violating versus stereotype-confirming trials in an IAT were related to mothers' gender stereotypes. Similarly, Healy et al. (2015) found that N2 amplitudes were larger during stereotype-confirming trials in an IAT when people held medium stereotypes. Moreover, differences in LPP amplitudes to stereotype-confirming and stereotype-violating trials were related to participants' hostile sexism (Canal et al., 2015).

Ultimately, there is a large variability in the direction of effects and the ERP components on which effects are found when social expectations are violated, most likely because of the multiple ways to measure people's reactions to the violation of social expectations. Moreover, differences exist in the extent to which people hold different expectations with regard to social norms. The current study was designed to determine which one of two experimental paradigms (the IAT or the IFT) elicited the most robust differences in ERP components (P1, N1, P2, N2, P3, N400, LPP) between trials that confirmed (stereotype-congruent) versus violated (stereotype-incongruent) gender expectations. Robustness in this study was defined as the paradigm's ability to elicit meaningful (i.e., in line with previous research) and consistent ERP components across two types of stereotype-confirming and stereotype-violating stimuli types (i.e., violating/confirming gender expectations about toys and behavior). We specifically examined people's responses to the violation of gendered expectations by young children, since children still show very explicit forms of gendered behaviors in their toy play (i.e., playing with cars or dolls) and behaviors (i.e., openly crying or showing aggressive behaviors; Blakemore et al., 2008). Children who violate gendered expectations have evoked negative reactions in both parents and non-parents (Endendijk et al., 2014; Sandnabba & Ahlberg, 1999; Sullivan et al., 2018).

Methods

Participants

Participants were 25 young adults (56% men) between the ages 22 and 31 (M_{age} = 26.1, *SD* = 2.77). Most participants were highly educated (i.e., 92% held a higher vocational degree or university degree). All participants were non-parents with normal or corrected-to-normal vision. Exclusion criteria were a neurological disease (e.g., Parkinson disease, multiple sclerosis), or a history of epileptic seizures, as these conditions are known to disturb EEG signals.

Procedures

Participants were recruited via the researchers' personal networks and university-related Facebook groups. Participants were unaware of the gendered nature of the study and were told to perform two tasks to see if they worked properly.

Participants were visited at home and they were asked to perform two tasks whilst undergoing simultaneous EEG examination. An IFT was administered, in which participants had to passively view child faces and toy/behavior words and rate face-word combinations on a scale from 1 to 9. In addition, participants were asked to perform a modified IAT in which they had to sort pictures and words as quickly as possible into two categories. Task order was counterbalanced so that half of the participants started with the IFT and vice versa. Participants were studied in a separate room to minimize external distractions. They were rewarded 5 euros in cash. Written informed consent was obtained pre-testing. Ethical approval was granted by the faculty ethical review board from the social and behavioral sciences faculty at Utrecht University, number 19–232.

Impression Formation Task

Stimuli

Twenty pictures of Caucasian children with a neutral facial expression (10 boys, 10 girls) were selected from the CAFE database (LoBue & Thrasher, 2015). The pictures selected have previously been used in a similar paradigm and represented the most clearly male-typed boys and female-typed girls (Endendijk et al., 2019a). The pictures' brightness levels were adjusted so that the mean luminance ranged between 195 and 205.

Next to the face pictures, a stimulus set was created with 10 masculine toy words (crane, tractor, race car, garage, toolkit, soccer, digger, fire truck, pirates costume, helicopter) and 10 feminine toy words (tea set, princess dress, hula-hoop, doll clothing, barbie, play kitchen, jewelry, doll house). These toys were clearly defined as masculine and feminine in previous studies (Blakemore & Centers, 2005; Endendijk et al., 2014, 2019a). Thus far, studies on the neural correlates of implicit gender stereotypes have solely focused on stereotypes about boys' and girls' toy and activity preferences. However, adults also hold gendered expectations about young children's personality and behavior characteristics (Martin, 1995). Therefore, a second stimulus set was derived from the externalizing and internalizing behavior scales from the Child Behavior Checklist (CBCL; Achenbach, 1999). We selected 10 words reflecting internalizing behavior (dependent, shy, unhappy, depressed, sad, fearful, worried, ashamed, avoidant, sensitive) and 10 words reflecting externalizing behavior (violent, fighting, threatening, kicking, agitated, inattentive, noisy, cruel, disobedient, aggressive). To select these words, 55 young adults (M_{age} = 22.2, SD = 2.52, 43.6% male) were asked to rate 39 descriptions of behavior on a scale from 1 (highly typical for females) to 5 (highly typical for males). These ratings were analyzed with a one-sample T-test to see whether the descriptions were rated as significantly more male-typed or female-typed than the neutral mid-point of the scale (lowest M_{diff}: 0.255, $t(54) = -3.422$, $p = 0.001$, for unhappy/feminine; see Supplementary Table S1 for an overview of the CBCL words tested and T-statistics for each word). The selected words were rated as most male-typed or female-typed (i.e., largest mean difference from the neutral midpoint of the scale) by the adults. Male- and female-typed words were matched on number of syllables (2–4 syllables) in both the toy stimulus set and the behavior stimulus set.

Task design

The task consisted of two blocks, each containing 120 trials. In each trial, participants were presented with a picture of a child with a neutral facial expression, after which a toy (block 1) or behavior (block 2) word appeared. Participants were told in the first block that this word described a toy the child loves to play with and that they had to quickly form an impression of each child based on the information that was provided. In the second block, the instructions were that the word described behavior that the child frequently exhibits. For half of the number of trials but randomly assigned, a question appeared after the face–word combination. This question was: How appropriate do you think this toy/behavior is for the child's gender? Participants were instructed to evaluate the face-word combinations based on their first impressions. Answers were given by pressing 1–9 on the keyboard with higher scores indicating that the participant thought the toy/behavior was more appropriate.

The task took 18–22 minutes to complete, depending on the length of the self-paced break in between the two blocks. Each face picture appeared a total of 12 times, 6 times with a word that was congruent with gender stereotypes (e.g., boy face paired with the word "crane", girl face paired with the word "sad") and 6 times with gender-stereotype incongruent words (e.g., boy face paired with the word "tea set", girl face paired with the word "aggressive"). The words were pseudo-randomly assigned to the child pictures, ensuring no word stimulus appeared twice with the same child face picture and each child face picture had appeared once, before being presented a second time. Each trial started with a fixation cross lasting for a varying amount of time (800, 900, 1000, 1100, or 1200 ms, randomly chosen) after which the face picture (1000 ms, width: 13.3 cm, height: 9.2 cm) appeared, superimposed on a gray background (191;191;191). After a randomly assigned jittered interstimulus interval (200, 225, 250, 275, or 300 ms) the word stimulus was presented in black (1000 ms, Cambria, font size 55). During half of the trials the question was presented (Cambria font size 24) and appeared until the participant had pressed a response-key (1–9). The task was presented electronically on a 14-inch laptop with the use of E-Prime v3.0 (Taylor & Marsh, 2017).

Explicit gender attitudes about toys or behavior
Appropriateness ratings during the IFT were extracted and used as a measure of the level of explicit gender attitudes about toys and behavior per participant. Explicit gender attitudes about toys were calculated by subtracting the average appropriateness score (1–9) on incongruent trials in the toy block from the average appropriateness score on congruent trials in the toy block. The same difference score was calculated for the behavior blocks. A high positive score meant that a participant evaluated stereotype-congruent child-toy combinations or child-behavior combinations as more appropriate than stereotype-incongruent stimulus combinations.

Implicit Association Test

A modified IAT that was previously used to measure violations of gender expectations about children's toys in parents (Endendijk et al., 2013, 2019b) was extended by adding two blocks with behavior words. Participants were instructed to divide the stimuli, i.e., the toy pictures and behavior descriptions, between two children as quickly as possible, by means of pressing one of two keys (z, m) on the keyboard that were assigned to each child. Illustrations of the two children were presented continuously in the upper left and upper right corner of the monitor, superimposed on a white screen. The toy pictures and behavior descriptions were the same as described in the IFT.

The task consisted of four blocks (toy congruent; toy incongruent; behavior congruent; behavior incongruent) that each consisted of 68 trails and a practice block consisting of 20 trials. In the congruent blocks, participants were asked to assign feminine toys/behaviors to a girl and masculine toys/behaviors to a boy (e.g., assign a crane to a boy, assign "sad" to a girl). In the incongruent trials, the feminine toys/behaviors were assigned to a boy and the masculine toys/behaviors to a girl (e.g., assign a crane to a girl, assign "sad" to a boy). Participants were given a short description of the children in the beginning of each block. For instance, in the toy block the following instruction was given: "This is Linda. Linda loves dolls, barbies, princesses, playing with her hula-hoop and her play kitchen". In the behavior block and example of the instruction was: "This is Kees. Kees is shy and dependent. He is easily embarrassed and very sensitive. He is often sad, fearful and depressed". Clear exemplars of feminine and masculine toys and behaviors were chosen that covered the range of toy and behavior stimuli that would be used in that category. In the toy blocks, full-color toy pictures were presented in the middle of the screen until the participant pressed a response key. In the behavior blocks, behavior descriptions were presented in black (Courier New, font size 34).

Trials were separated by a 500 ms interstimulus interval. Jitter was created by the participants' varying response times (M = 902.62, SD = 695.62, range: 18–9244 ms). The order of blocks was counterbalanced, so that half of the participants started with a congruent block, and the other half of the participants started with an incongruent block. Participants were given a self-paced break between each block when new instructions were given. The task took 12–15 minutes to complete.

Implicit gender stereotypes

The improved scoring algorithm for the IAT was used to calculate the level of implicit gender stereotypes of the participant (Greenwald et al., 2003). A high positive score represented more difficulties (e.g., longer reaction times, more errors) during incongruent trials compared to congruent trials, indicating more stereotyped expectations about the appropriateness of certain toys and behaviors for girls and boys.

EEG recordings

During both tasks, EEG was recorded from 32 scalp sites with the use of BioSemi ActiveTwo Ag-AgCI pin electrodes and hardware (BioSemi, 2011). The electrodes were placed according to the 10–20 electrode system with use of a nylon electrode cap (Klem et al., 1999). EEG signals were amplified, bandpass filtered at DC-400 Hz and sampled at 2048 Hz. Eye movements were recorded with four sintered Ag-AgCI electrodes placed above and below the right eye and just outside the outer corners of each eye.

EEG data of each task was processed separately, but because of the large similarity in processing we only indicate which steps differed between the tasks. Data were downsampled to a 256 Hz sampling rate, after which the data were bandpass filtered between 0.1 and 30 Hz (IFT) and 4 and 30 Hz (IAT). Individual participants' data were re-referenced to the average activity in all channels. Ocular artifacts were corrected using the Gratton and Coles method as implemented in Brainvision Analyzer (Gratton et al., 1983). Data were then segmented into epochs of –200 ms to 1000 ms, time-locked to the onset of the toy and behavior stimuli. For the IFT, a baseline correction was applied from –200 to 0 to correct for differences in absolute voltage and drift between trials and electrodes. This was not done for the IAT paradigm in accordance with previous processing in ERP studies (Endendijk et al., 2019b; Forbes et al., 2012). By baselining, between-subject differences in preparatory activity would reduce variance in post-stimulus ERP amplitudes. However, this preparatory activity is characteristic to the IAT block design in which congruent and incongruent trials are separated. Therefore, as recommended in previous work, we decided to use high-pass filtering with 4 Hz instead of 0.1 Hz to decrease issues with systematic differences in pre-stimulus baseline activity (Bidet-Caulet et al., 2012; Endendijk et al., 2019b; Healy et al., 2015). Consequently, late-ERP components may be less reliable, since they mainly consist of lower EEG frequencies (Demiralp et al., 2001). Artifacts were rejected semi-automatically. Trials were marked as bad and manually inspected if the voltage step exceeded 50 uV/ms, with a maximum allowed difference of values in intervals of 100 uV within a 200 ms window, or with a lower activity in intervals of 0.5 uV.

Trials were discarded if, within the marked trial, the artifact appeared across two or more electrodes or on the electrode at one of the sites of interest. A channel was marked "bad" for that participant if artifacts were present in more than 25% of the trials. Channels that were marked as "bad" were discarded from preprocessing and further analysis. Participants were excluded if they had significant noise in more than 25% of the trials on multiple channels (see the supplementary materials for more details on data cleaning). The remaining data for each individual participant was averaged into eight grand average waveforms per condition (toy boy congruent, toy boy incongruent, toy girl congruent, toy girl incongruent, behavior boy congruent, behavior boy incongruent, behavior girl congruent, behavior girl incongruent) for each task. Finally, total average waveforms per condition were created from the grand average waveforms per participant.

ERPs

Grand average waveforms were visually inspected to select time windows and electrodes for the ERP components of interest. This was done per task and per block, since the two blocks differed in the type of words presented. The electrodes and time windows with the largest amplitudes were selected; see, Table 3.1 for the overview and Figure S1-S4 for the grand average waveforms for the selected electrodes per task and block.

Table 3.1. Selected time windows and electrodes per ERP per block

		Toy block		Behavior block		
Task	ERP	time window	electrodes	time window	electrodes	In accordance with
IFT	P1	95-140	PO3, PO4, O1, O2, Oz	90-130	PO3, PO4, O1, O2, Oz	Dickter and Gyurovski (2012); He et al. (2009).
	N1	165-180	PO3, PO4, O1, O2	165-180	PO3, PO4, O1, O2	Dickter and Gyurovski (2012).
	P2	185-205	Oz	185-205	Oz, O1, O2	Dickter and Gyurovski (2012); He et al. (2009).
	LPP	450-650	Pz, PO3, PO4	360-550	Fz, Cz, FC1, FC2	Ito et al. (2004); Williams and Themanson (2011).
IAT	N2	300-360	Fz, Cz, FC1, FC2	285-340	Fz, Cz, FC1, FC2	Endendijk et al. (2019b).
	P3	360-420	Fz, Cz, FC1, FC2	375-425	Fz, Cz, FC1, FC2	Endendijk et al. (2019b).

Note. ERP = event-related potential. IFT = Impression Formation Task. IAT = Implicit Association Test.

3

Statistical analyses

Average waveform amplitudes per subject were imported in RStudio v.1.4.17 (R Core Team, 2013). The data were analyzed using multilevel modeling with the *lme4* package (Bates et al., 2018, 2007) with maximum likelihood (ML). Since we expected participants to differ in their neural activation patterns irrespective of task and condition, we chose to allow intercepts and slopes to vary per participant in our models (i.e., participant ID was a random factor in the models). Additionally, we used multiple electrodes to quantify each ERP component, and activity can be expected to vary across electrodes. We therefore included electrode as an additional random factor in our models. The average amplitudes were outcome variables in the models, and congruence and gender of the child in the picture (stimulus gender) were the main variables of interest and thus added as predictors. Gender of the participant and gender stereotypes and attitudes were additionally added as possible covariates. The Akaike Information Criterion (AIC; Bozdogan, 1987) was used to determine model fits. Model fit was compared between models with the *anova* function in R, and the log likelihood ratio test was used to assess model significance. Separate analyses were performed for each task, within which ERPs for toy and behavior stimuli were individually modeled. The main factor of interest was congruence, as this factor provided information on the differential neural processing of stimuli that violated versus confirmed gender expectations. Interaction terms were also added between the factor of interest congruence and stimulus gender, participant gender, implicit gender stereotypes and explicit gender attitudes. This resulted in the following model entered in R:

Amplitude~Congruence+Stimulus.Gender+Impl.stereotype+Part.Gender
+Expl.attitudes+Congruence*Stimulus.Gender
+Congruence*Impl.stereotype+Congruence*Part.Gender
+Congruence*Expl.attitudes+(Congruence
*Stimulus.Gender|PartID)+(1|PartID:Electrode)

We used Cook's distance to detect outliers per component. Influential cases were defined as being more than the 95^{th} percentile. Outliers were substituted by the value of the 95^{th} percentile and analyses were repeated with and without outliers to see if they affected the results. Including them changed the slope, but not the significance of the results. Outliers were thus corrected and included. Interaction effects were post-hoc analyzed with the use of a paired sample t-test. Effect sizes were estimated by calculating Pearson correlations, with $r = 0.1$ representing a small effect size, $r = 0.3$ a medium effect size, and $r = 0.5$ a large effect size (Cohen, 2013).

Results

Descriptive statistics

The data were checked on linearity of predictors, homogeneity of variance, multicollinearity, normally distributed errors, and outliers. Two participants were excluded from the IAT analyses due to excessive noise in the EEG recordings. No participants were excluded from the IFT analyses. We additionally assessed whether men and women differed in terms of background variables; see, Table 3.2 for mean and standard deviations of the variables of interest. Men were on average older than women ($t(25) = 44.696, p < 0.001$). Men and women had comparably high educational levels, ($F(23) = 0.309, p = 0.584$) and did not significantly differ in their average levels of implicit gender stereotypes as measured with the IAT ($F(22) = 0.366, p = 0.551$). For both men and women, average appropriateness ratings were higher for congruent than incongruent trials in the toy block (men : $M_{congruent} = 6.65$, $SD_{congruent} = 1.28$,

$M_{incongruent} = 3.90$, $SD_{incongruent} = 1.32$; women: $M_{congruent} = 6.83$, $SD_{congruent} = 0.58$, $M_{incongruent} = 5.17$, $SD_{incongruent} = 1.12$) and the behavior block (men: $M_{congruent} = 5.39$, $SD_{congruent} = 0.72$, $M_{incongruent} = 4.32$, $SD_{incongruent} = 0.96$; women: $M_{congruent} = 5.27$, $SD_{congruent} = 0.41$; $M_{incongruent} = 4.23$, $SD_{incongruent} = 0.49$). Men differed more in their evaluation of congruent versus incongruent trials than women, which indicated that men held more traditional gender attitudes about children's toys ($t(48) = 5.902$, $p < 0.001$) and behavior ($t(48) = 3.788$, $p < 0.001$) than women.

Table 3.2. Correlation matrix between factors of interest

Correlation matrix				Men			Women		
	1.	2.	3.	M	SD	Range	M	SD	Range
1. Age	-			27.50	2.59	24 - 31	24.20	1.69	22 - 27
2. IGS	-0.128	-		1.06	0.59	-0.37 - 1.67	1.13	0.40	0.27 - 1.66
3. GA toy	0.017	0.338	-	2.75	1.39	0.33 - 4.93	1.66	1.38	-1.03 - 3.93
4. GA behav	-0.103	0.316	0.270	1.06	0.76	-0.33 - 2.63	1.03	0.42	0.37 - 1.73

Note. IGS = implicit gender stereotypes, GA = gender attitudes, behav = behavior

3

IFT

In Table 3.3 an overview of all findings is presented separately for the IFT and IAT, showing effects of congruence, and whether congruence additionally interacted with a variable of interest on the ERP amplitudes.

Table 3.3. Overview of findings per task, per block and for each ERP

Task	Block	ERP	Congruence effect	Dependent on
IFT	Toy	P1	no	
		N1	no	
		P2	no	
		LPP	no	
	Behavior	P1	yes	Implicit stereotypes
		N1	yes	Gender stimuli
		P2	no	
		LPP	yes	Gender attitudes
IAT	Toy	N2	no	
		P3	no	
	Behavior	N2	no	
		P3	yes	Implicit stereotypes

Note. ERP = event-related potential. IFT = Impression Formation Task. IAT = Implicit Association Test, LPP = late positive potential.

Toy

P1. P1 amplitude was negatively associated with implicit gender stereotypes independent of stimulus type or congruence ($\beta = -0.315$, $t(25) = -2.177$, $p = 0.039$, $r = 0.399$). All other main effects and interactions with congruence were non-significant (ps > 0.05).

N1. Since there were some indications that P1 amplitude differences continued in N1 amplitudes, we corrected N1 amplitude for preceding P1 amplitudes in overlapping electrodes. The uncorrected N1 results can be found in the supplementary materials. A significant main effect for explicit gender attitudes was found ($\beta = 0.250$, $t(25) = 2.072$, $p = 0.049$, $r = 0.383$). Stronger gendered attitudes were associated with larger N1 amplitudes regardless of congruence or stimulus gender. All other main effects and interactions were non-significant (ps > 0.05).

P2. P2 amplitude was negatively associated with implicit gender stereotypes ($\beta = -0.448$, $t(25) = -2.823$, $p = 0.009$, $r = 0.492$), irrespective of stimulus type or congruence. All other effects were non-significant (ps > 0.05).

LPP. LPP amplitudes were negatively related to implicit gender stereotypes irrespective of stimulus type or congruence ($\beta = -0.424$, $t(25) = -3.171$, $p = 0.004$, $r = 0.536$). All other effects were non-significant (ps > 0.05).

Behavior

P1. A significant main effect was found of implicit gender stereotypes ($\beta = -0.318$, $t(25) = -2.110$, $p = 0.045$, $r = 0.389$), as well as a significant interaction between congruence and implicit stereotypes ($\beta = 0.165$, $t(25) = 3.064$, $p = 0.005$, $r = 0.522$). Inspecting the data revealed that less strong gender stereotypes were associated with a larger P1 to congruent versus incongruent trials, whereas stronger implicit gender stereotypes were associated with a larger P1 toward incongruent versus congruent trials (see Figure 3.1). All other effects and interactions were non-significant (p-values > 0.05).

N1. Since there were some indications that P1 amplitude effects carried over to N1 amplitudes, P1 amplitudes were added as a covariate to the analysis of N1 amplitudes. A significant interaction was found between stimulus type and congruence ($\beta = 0.166$, $t(25) = 2.467$, $p = 0.021$, $r = 0.442$). Post-hoc analyses revealed that N1 amplitude was significantly larger for boys' pictures paired with incongruent behavior (i.e., internalizing) than when paired with congruent behavior (i.e., externalizing) ($t(99) = 4.433$, $p < 0.001$, $r = 0.407$) but this difference was not found for girls' pictures ($t(99) = -1.558$, $p = 0.123$). In addition, congruent-girl trials elicited a significantly larger N1 effect than congruent-boy trials ($t(99) = 3.333$, $p = 0.001$, $r = 0.318$), whereas incongruent-boy trials elicited a significantly larger N1 effect than incongruent-girl trials ($t(99) = -3.092$, $p = 0.003$, $r = 0.297$; see Figure 3.2).

P2. The P2 model resulted in a significant negative main effect of implicit gender stereotypes on P2 amplitudes ($\beta = -0.369$, $t(25) = -2.279$, $p = 0.032$, $r = 0.415$). All other effects were non-significant (smallest *p*-value = 0.053 for a main effect of congruence).

LPP. A significant main effect was found for explicit gender attitudes ($\beta = 0.221$, $t(25) = 2.150$, $p = 0.042$, $r = 0.395$). Second, a significant interaction was found between congruence and explicit gender attitudes ($\beta = -0.098$, $t(25) = -2.115$, $p = 0.045$, $r = 0.390$). As depicted in Figure 3.3, more traditional gender attitudes about behavior were associated with larger LPP amplitudes in response to congruent compared to incongruent trials, whereas less traditional gender attitudes were associated with larger LPP amplitudes in response to incongruent compared to congruent trials. All other effects and interactions were non-significant (*p*s > 0.05).

3

Figure 3.1. The effect of implicit gender stereotypes on the difference scores of P1 amplitudes during the behavior block of the Impression Formation Task, as calculated by subtracting incongruent trials from congruent trials.

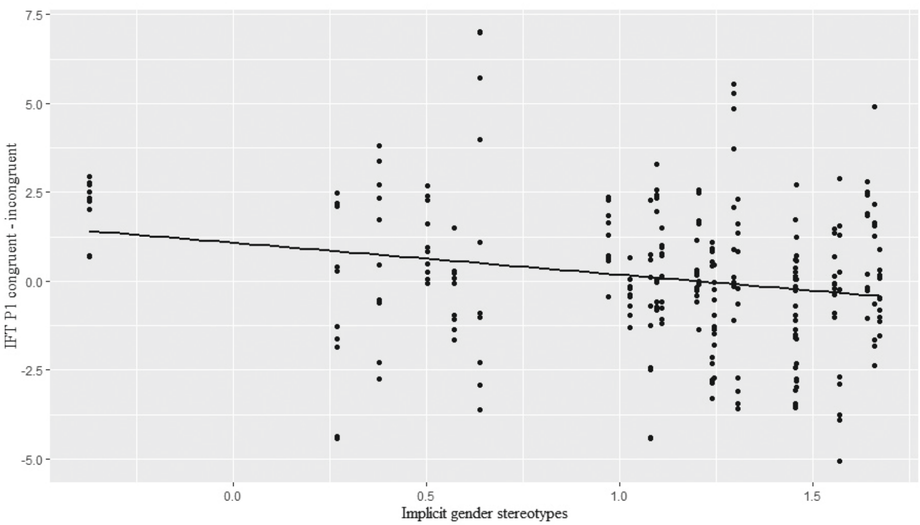
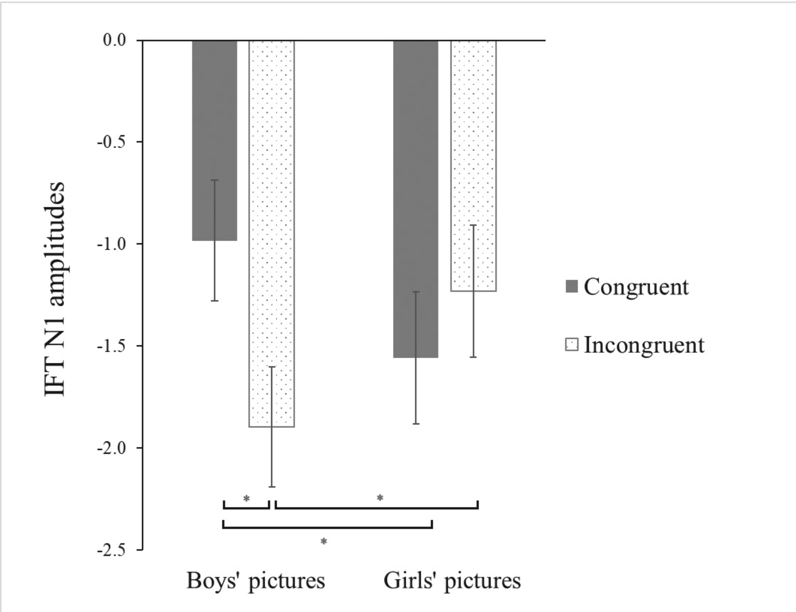
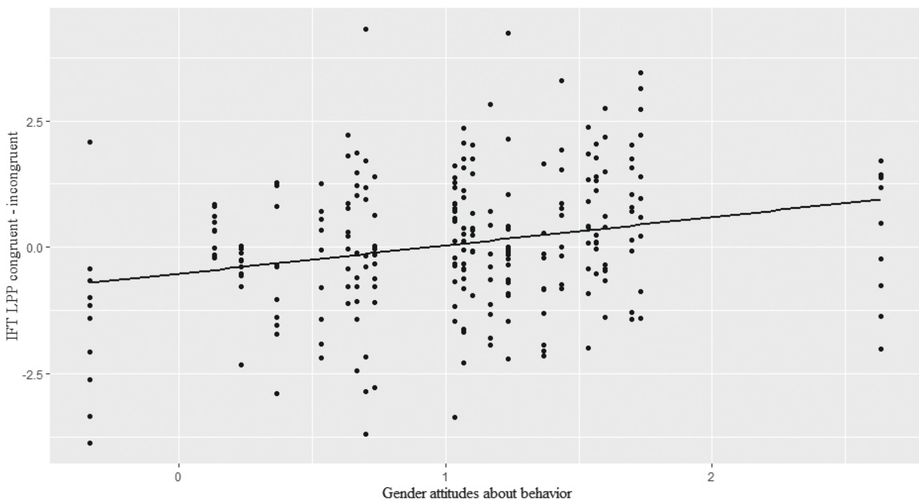


Figure 3.2. N1 amplitude during an IFT to stimuli that violated gendered expectations about behavior (i.e., incongruent) and stimuli that confirmed gendered expectations about behavior (i.e., congruent), separate for boys' pictures and girls' pictures.



Note. The asterisk indicates a statistically significant difference between trials.

Figure 3.3. The effect of gender attitudes about behavior on the difference score of LPP amplitudes during the behavior block of the Impression Formation Task, as calculated by subtracting congruent from incongruent trials.



IAT

Toy

N2. No significant effects emerged from the N2 model (all *p*-values > 0.05).

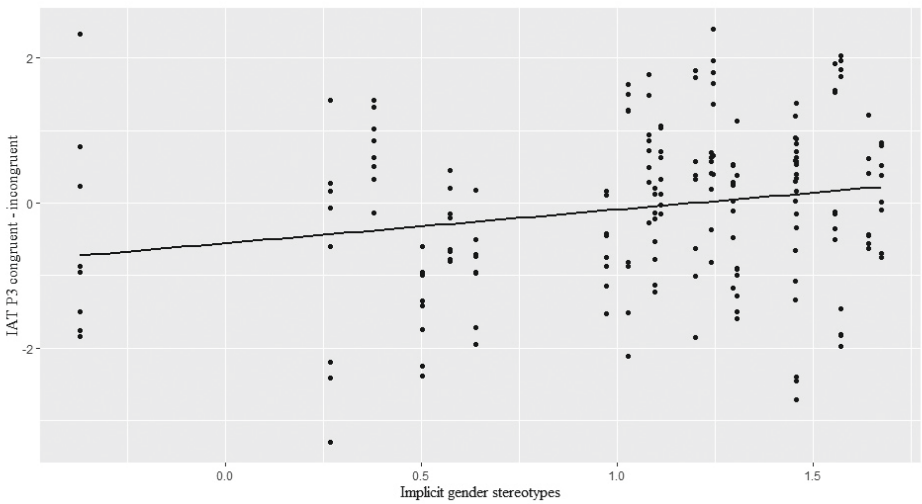
P3. With regard to the P3, a significant main effect of stimulus type ($\beta = 0.322$, $t(23) = 2.422$, $p = 0.024$, $r = 0.451$) was found, indicating that assigning toys to girls elicited a larger P3 amplitude than assigning toys to boys, regardless of which type of toy was presented.

Behavior

N2. The model assessing N2 amplitude effects did not yield any significant results (smallest *p*-value = 0.280 for main effect congruence).

P3. A significant interaction emerged between congruence and implicit stereotypes ($\beta = -0.191$, $t(23) = -2.603$, $p = 0.016$, $r = 0.477$; see Figure 3.4). More traditional implicit gender stereotypes were associated with larger P3 amplitudes toward congruent than incongruent trials, whereas less traditional gender stereotypes were associated with larger P3 amplitudes toward incongruent than congruent trials.

Figure 3.4. The effect of implicit gender stereotypes on the difference score of P3 amplitudes during the congruent vs. incongruent behavior block of the Implicit Association Test, as calculated by subtracting congruent from incongruent trials.



Discussion

The current study examined the robustness of the neural activation patterns of two experimental paradigms when participants were either actively (IAT) or passively (IFT) exposed to visual stimuli that confirmed versus violated gender expectations. Although both tasks elicited significant ERP differences between stimuli that confirmed or violated gender expectations, the IFT evoked effects of stimulus' congruence with gender expectations on all but one ERP components of interest (P1, N1, and LPP). The IAT only showed an effect of stimulus congruence on P3 amplitude, and not on N2 amplitude. However, it must be noted that for the IFT, more ERP components were selected and tested than for the IAT. To evaluate whether the congruence effects we found with the IFT and IAT are relevant and interpretable in the context of expectancy violations, we will discuss them in light of previous research on the processes related to each ERP component.

Congruence ERPs elicited in the IFT

Regarding the IFT, a larger P1 to expectancy-violating vs. expectancy-confirming child-behavior stimuli was associated with stronger implicit gender stereotypes, whereas a larger P1 to expectancy-confirming vs. expectancy-violating stimuli was associated with less strong gender stereotypes. This finding indicated that stimuli that violate people's own stereotyped expectations about gender appear to be associated with increased visual processing (Luck, 2014). Previous research also demonstrated that stimuli that violated gender expectations elicited higher P1 amplitudes (Liu et al., 2017), but individual differences in gender stereotypes were not taken into account.

Next to the effects on P1, the IFT evoked effects of stimulus congruence on the N1 for the behavior trials. As previous research found larger N1 amplitudes for expectancy-violating stimuli compared to expectancy-confirming stimuli (Dickter & Gyurovski, 2012), our findings might indicate that boys paired with feminine behaviors violate gender expectations to a larger extent than girls paired with masculine behavior. This fits with previous findings that gender stereotypes are more restrictive for boys than girls (Kane, 2006; Sandnabba & Ahlberg, 1999). We did not find differences in N1 effects during the toy block. This difference between the toy and behavior block might be attributed to the more negative connotation of the behavior stimuli compared to the toy stimuli. The N1 has been specifically implicated in research on negative words, with larger peaks reflecting early detection of relevant emotional information (Bernat et al., 2001).

Finally, the IFT elicited effects of stimulus congruence on the LPP for the behavior conditions of the task only. Larger LPP amplitudes in response to expectancy-confirming children were associated with participants' more traditional explicit gender attitudes (i.e., evaluating expectancy-confirming children as more appropriate than expectancy-violating children). Williams and Themanson (2011) also found a larger LPP in expectancy-confirming trials of a gay-straight IAT. Larger LPP might reflect (controlled) attentional orienting to salient stimuli (e.g., Hajcak et al., 2013; Spreckelmeyer et al., 2006), which in the current study are children that show behavior that people evaluate as appropriate.

Congruence ERPs elicited in the IAT

By studying the activation patterns of the IAT, only the P3 was affected by congruence during the behavior block. However, the finding that P3 was larger for expectancy-confirming than expectancy-violating trials for people with stronger implicit gender stereotypes, was not in line with P3 being associated with attentional focus on unexpected items (Polich, 2007) or negatively valanced stimuli (Duval et al., 2013; Gyurovski et al., 2018). For people with strong implicit stereotypes expectancy-violating stimuli would constitute unexpected or negatively valanced stimuli, which we expected to elicit larger P3, similar to a previous study (Bartholow & Dickter, 2007). The unexpected findings for the P3 with the IAT might be due to the high-pass filtering that was necessary for the IAT data, which made late-ERPs (e.g., P3, N400) less reliable as these ERPs often consist of lower EEG frequencies in the delta band (0–4 Hz; Demiralp et al., 2001).

Other important findings

It is important to note that no main effect of congruence was found on ERP amplitudes, only interactions with other variables. Previous studies have indicated that ERP amplitude differences toward expectancy-violating and expectancy-confirming trials was dependent on the level of implicit (gender) stereotypes (e.g., Endendijk et al., 2019b; Healy et al., 2015), hostile sexism (Canal et al., 2015) or participants' gender (Proverbio et al., 2018). When such interactions are found, between-group variation in ERPs toward congruent and incongruent trials may cancel each other out. The current results confirm the need to consider participants' level of gender stereotypes or gender attitudes in research on the neural processing of violations of gender expectations.

Another important finding of this study is that people's brains also seem to respond differently toward the violation of gendered expectations about behaviors versus toys. For instance, more consistent differences in brain responses were observed when people's gendered expectations about behaviors were violated vs. confirmed, than when people's expectations about toys were violated. People may have responded more strongly toward the violation of expectations about problem behaviors, because these behaviors have a negative connotation and bad events generally have a larger impact on people than good events (Baumeister et al., 2001). In addition, the findings regarding violations of gendered expectations about problem behavior extend previous research that focused on toys (Endendijk et al., 2019b), emotion expression (Liu et al., 2017), or gender-typed traits and activities (Proverbio et al., 2018; White et al., 2009). Adults generally expect boys to possess more masculine traits, such as being dominant, independent, competitive, and aggressive, whereas girls are expected to possess more feminine traits, such as being gentle, neat, sympathetic, weak, shy, overly emotional, and feminine looking (Koenig, 2018; Martin, 1995; Powlishta, 2000). Our results confirm that people hold gendered expectations about internalizing and externalizing behaviors, and that violation of these expectations is visible in distinct brain activity patterns. Future research could examine whether brain responses to the violation of gendered expectations about child problem behaviors may underlie why parents socialize boys and girls to differently express their emotions (i.e., internalizing or externalizing emotions; Chaplin et al., 2005).

Limitations and directions for future research

The findings from this study must be interpreted in light of its limitations. Firstly, the small sample size reduced the power for between-subjects comparisons. Thus, the interactions gender stereotypes and attitudes need to be interpreted with caution. Also, adding random slopes to the multilevel models greatly reduced the power to detect medium and small effects in congruence. Although random slopes are recommended to reduce the probability of type-I errors (Heisig & Schaeffer, 2019), more power is needed to detect smaller effect sizes (Clayson et al., 2019). Future studies with larger sample sizes are therefore needed to confirm whether neural processing of gendered stimuli differs between male and female participants and varies with the strength of people's gender stereotypes and attitudes. In addition, different ERP components have been selected for the IFT and IAT, which hampers direct comparison between the two tasks. Moreover, we examined neural reactions to children violating gender expectations in non-parental adults. It could be that parents have stronger, or less strong, expectations when it comes to children, and thus may respond differently than non-parents when these expectations are violated. In this study, we have only examined the violation of social expectations with regard to (child) gender. Therefore, further research is necessary to confirm whether the IFT is more suitable than the IAT to assess violations of social expectations across other social domains than gender (e.g., race, age, sexual orientation). Nonetheless, we have been able to find more robust effects with the IFT, which encourages future research to examine the neural correlates of violations to social (gender) expectations with the use of an IFT.

Conclusion

The findings from the IFT show that this experimental paradigm is more suitable than the IAT to combine with EEG research on the neural processes underlying people's responses to violations of gender expectations. The IFT elicited more relevant ERP patterns in response to stimuli that violated social expectations than the IAT, with the latter experiencing some drawbacks in EEG processing due to its block design. Based on these findings, we recommend future research examining the neural processes underlying violations to social expectations to use impression formation paradigms, in which people are exposed to stimuli that violate and confirm social expectations.

4

Mothers' and fathers' neural responses toward gender-stereotype violations by their own children

Christel M. Portengen, Anneloes L. van Baar, & Joyce J. Endendijk
Clinical Child and Family Studies, Utrecht University, Utrecht, the Netherlands

This chapter is submitted for review.

Abstract

Gender stereotypes facilitate people's processing of social information by providing assumptions about expected behaviors and preferences. When gendered expectations are violated, people often respond negatively, both on a behavioral and neural level. Little is known about the impact of family kinship on the behavioral and neural reactions to gender-stereotype violations. Therefore, we examined whether parents show different responses when gender stereotypes are violated by their own children versus unknown children. The sample comprised 74 Dutch families with a father (M_{age} = 37.54), mother (M_{age} = 35.83), son and daughter aged 3-6 years. Electro-encephalography (EEG) measurements were obtained while parents viewed pictures of their own and unknown children paired with toy or problem behavior words that violated or confirmed gender stereotypes. In half of the trials, parents evaluated the appropriateness of toy-gender and behavior-gender combinations. Parents showed stronger LPP amplitudes toward gender stereotype-violating behaviors by own children compared to unknown children. Moreover, parents' P1 responses toward gender stereotype-violating child behaviors were stronger for boys than for girls, and for parents who evaluated gender-stereotype violations as less appropriate than gender-stereotype confirmations. The findings indicated that gender-stereotype violations by parents' *own* children are particularly salient and viewed as less appropriate than gender-stereotype confirmations.

Introduction

In a complex social world people quickly need to process information to understand what is happening and to adapt their behavior accordingly. Gender stereotypes facilitate fast processing of social information by providing assumptions about the expected behavior, roles, and characteristics of men and women (Darley & Gross, 1983). Gender stereotypes can simultaneously be descriptive and prescriptive (Koenig, 2018). The descriptive component of gender stereotypes refers to the beliefs that people have about what a man or woman normally does. The prescriptive component of stereotypes revolves around how a man or woman should behave. Violations of prescriptive gender stereotypes generally elicit strong negative responses in people (Koenig, 2018; Rudman et al., 2012a; Rudman et al., 2012b; Sullivan et al., 2018).

In line with these findings, parents respond more negatively toward children who violate gender stereotypes (e.g., a boy playing with dolls) than children who adhere to gendered norms (e.g., a boy playing with cars) (Endendijk et al., 2014; Friedman et al., 2007; Kane, 2006). Also, parents expect children who do not adhere to traditional gender norms to be less well-adjusted later in life than children who do adhere to gender norms (Sandnabba & Ahlberg, 1999). To increase insight into the underlying mechanisms associated with people's negative responses to gender-stereotype violations, social neuroscientists have identified several key brain areas that play a prominent role in the processing of stereotyped information (Amodio, 2014; Stanley et al., 2008).

However, thus far, most of the studies who focused on parents' responses to gender-stereotype violations have examined brain responses to the violation and confirmation of gendered expectations about children in general. Little is known about parents' neural responses to gender-stereotype violations and confirmations when it concerns their *own* children. It is important to gain more knowledge on how parents process and respond to violations of gender stereotypes by their own children (compared to other children), since these processes might better explain gendered parenting behaviors with their own children than neural processing of other children's behavior that violates gender stereotypes. In addition, comparing parents' neural responses to own and other children allows for the investigation of the impact of familial kinship on the neural processing of gender-stereotype violations. Gaining information about parents' neural processing of gendered behavior of their own children (vs. other children) would moreover further the knowledge on the ecological validity of social neuroscientific research (Derks et al., 2013; Feldman, 2015).

The literature to date provides little clarity about whether parents would respond stronger, or less strong, to the violation of gender stereotypes when it concerns their own versus other children. Yet, parents and their children have strong affectional ties. Not surprisingly, research shows that parents' own children evoke stronger physiological (Wiesenfeld & Klorman, 1978; Wiesenfeld et al., 1981), hormonal (Feldman, 2015), and neural (Bornstein et al., 2013; Doi & Shinohara, 2012) responses than unknown children. Based on the social judgment literature (Krueger & Rothbart, 1988) and research on parental cognitions, two contrasting hypotheses can be formulated with regard to parents' neural responses toward gender-stereotype violations of own versus unknown children.

First, individuating information (i.e., information that makes a person an individual instead of a group member) and familiarity with a person's character and preferences have the ability to override the impact of stereotyped expectations of people and alter neural responses toward people (Krueger & Rothbart, 1988; Mende-Siedlecki, 2018; Quinn et al., 2009). Parents generally possess ample individuating information about their own children but less for other children (Eccles et al., 1990). The personalized information of one's own children (e.g., knowing their son likes dolls) thus might decrease the likelihood parents resort to gender stereotypes (e.g., expecting their son to play with cars) when they think or make judgments about their own children compared to other children (Rubinstein et al., 2018). There is some evidence to support this claim. One cross-sectional study among Swedish mothers found that parents of 5-year-olds described their children as less rough than parents of younger children expected for their children at the age of five (Servin & Bohlin, 1999). This finding indicated that parents' expectations may partly depend on their own children's preferences and characteristics, despite expecting different behaviors when individuating information about their child at that age was not available. Moreover, individuating information about parents' own child was found to have a stronger effect on parents' judgments of their child's math, sports, and social abilities than parents' gender stereotyped expectancies (Jacobs & Eccles, 1992).

Relatedly, self-serving bias may cause parents to respond less negative or strong to their own child's gender nonconformity than to gender nonconformity in unknown children. The self-serving bias entails that people ascribe their successes to internal characteristics and their failures to external factors to maintain a positive self-concept (Bradley, 1978; Zuckerman, 1979). Parents might view their children as an extension of themselves and therefore, their self-serving bias extends to their child's behaviors as well (Montemayor & Ranganathan, 2012; Sedikides et al., 1998). Accordingly, parents tend to ascribe negative behavior by their own children more to external factors than similar behavior from unknown children which they often attribute more to internal factors (Larrance & Twentyman, 1983; Montemayor & Ranganathan, 2012). Moreover, internal attributions evoke more negative parenting reactions than external attributions (Bugental & Corpuz, 2019). Therefore, one could assume that parents react more negatively toward unknown children's gender nonconforming behaviors than their own children's nonconforming behaviors since parents attribute this behavior more to internal characteristics for unknown children.

On the other hand, parents, particularly those parents with strong gender stereotypes, might react more negative to gender-stereotype violations in their own children versus other children. It was suggested that parents might fear that they or their child will be stigmatized and bullied when their child exhibits gender nonconforming behaviors (Abreu et al., 2022; Averett, 2016; Goldberg, 2009; Rudman & Fairchild, 2004). In order to prevent this, parents might for instance set rules for the display of gender nonconformity by allowing gender-nonconforming behaviors indoors but prohibiting the display of gender nonconformity outside the house (Rahilly, 2015; Scheibling, 2022). Thus, parents might respond stronger to gender-stereotype violations of their own versus other children because they want to protect their children from social backlash.

Neural responses toward the violation of gender stereotypes

One way to measure parents' reaction to gender-stereotype violations is by using neuroscientific methods to examine parents' brain processes. Importantly, this method has been found to be a more robust predictor of parents' gender socialization practices with their children than behavioral measurements of parents' reactions to gender-stereotype violations or parents' implicit gender stereotypes (Endendijk et al., 2019b). Parents' neural responses to gender stimuli have most often been examined by comparing patterns of neural activation around the presentation of stimuli, so-called event-related potentials (ERPs). Previous ERP studies have identified several components that are of interest when examining parents' neural responses toward the violation and confirmation of gender stereotypes. For instance, the P1, N1, and P2 components have been associated with early attentional and information processing and the former two are considered proxies for activity in the dorsal visual stream (Di Russo et al., 2003; Novitskiy et al., 2011). Regarding the P1, angry female faces (gender-stereotype violations) were found to elicit higher P1 amplitudes than happy female faces (gender-stereotype confirmations) (Liu et al., 2017). The N1 has been found to be larger toward expectancy-violating trials than expectancy-confirming trials (Dickter & Gyurovski, 2012; Portengen et al., 2022). Results regarding the P2 have been less consistent, with studies finding larger, smaller, and no difference in P2 amplitudes toward the violation versus confirmation of social expectations (Jerónimo et al., 2017; Portengen et al., 2022; Yang et al., 2020).

Apart from these three early components, two later neural components have also frequently been implicated in gender-stereotype research, namely the P3 and the late positive potential (LPP). First, the P3 has mostly been associated with attention to unexpected events (Polich, 2007), with higher amplitudes commonly reflecting the level of stimulus-evoked surprise (Mars et al., 2008). Moreover, P3 responsivity has been thought to index the updating of a memory representation evoked by the level of expectancy violation of the presented stimulus (Polich, 2007). The P3 has indeed been found to be larger during expectancy-violating trials than expectancy-confirming trials (Bartholow & Dickter, 2007). Lastly, the LPP is a occipital-parietal located component which has been coupled with an extensive brain network of cortical and subcortical structures that differentially respond depending on the valence of a stimulus (Liu et al., 2012). The LPP functions as a measure of motivational salience (Hajcak et al., 2009) and has been found to be larger toward both gender-stereotype confirmations and violations (Liu et al., 2017; Osterhout et al., 1997). In sum, several early (P1, N1, P2) and late (P3, LPP) components have been identified in earlier research on gender-stereotype violations, that are related to attentional and salience processing of (unexpected) events and the updating of gender-related schemas in the brain.

The role of gender in the neural processing of stereotype violations

Gender of the parent (i.e., perceiver) as well as gender of the child (i.e., the target) also play a pivotal role in the neural processing of gender-stereotype violations. In general, gender-stereotyped expectations and gender norms are more restrictive for boys than for girls (Kane, 2006; Sandnabba & Ahlberg, 1999). Moreover, parents are generally more accepting of their daughter's gender nonconforming behaviors than of their sons (Solebello & Elliott, 2011). This can also be seen on a neural level: boys with internalizing problem behavior (e.g., sadness, anxiety; stereotype-violating) elicited larger N1 amplitudes than boys with externalizing problem behavior (e.g., aggression, anger; stereotype-confirming), but this difference was not found for girls (Portengen et al., 2022). This indicates that the violation of gender stereotypes might be viewed as more negative for boys than for girls and would therefore evoke stronger neural responses in parents.

Mothers and fathers might also differ in their neural processing of gender stereotypes. In general, fathers have stronger gender-stereotyped expectations of their children (Kollmayer et al., 2018), which is also reflected in their stronger neural responses toward (gender) stereotype violations (Proverbio et al., 2018). Moreover, men fear being evaluated as gender atypical more than women (Vandello et al., 2008), are more likely to reject child nonconforming behaviors, and to hold themselves accountable for their son's non-conforming behaviors (i.e., feeling like a bad father when their son is gender-atypical) (Kane, 2006). However, fathers and mothers are equally likely to respond negative toward their children's gender nonconforming behaviors (Grossman et al., 2005). Thus, based on the majority of studies on this topic, we expect fathers to respond stronger to children's gender-stereotype violations than mothers.

Gender cognitions and the neural processing of gender stereotypes

Moreover, individual differences in the strength of gender-stereotyped expectations can play a role in parents' neural responses toward gender-stereotype violations. Indeed, several studies have found indications that ERP amplitude differences were related to a person's gender cognitions. For example, a larger P1 amplitude toward gender stereotype-violating than gender-stereotype confirming preschoolers was associated with stronger implicit gender stereotypes (Portengen et al., 2022). Moreover, mothers' P3 activity elicited by gender-stereotype violations and confirmations were found to be related to their level of gender stereotypes (Endendijk et al., 2019b). Additionally, differences in LPP amplitudes elicited during stereotype-confirming and stereotype-violating trials have been found to be related to a person's level of hostile sexism (Canal et al., 2015) and gender attitudes (Portengen et al., 2022). It is thus important to take parents' gender cognitions into account when examining parents' neural responses toward gender-stereotype violations.

Current study

In sum, there are indications that parents' gender, children's gender, and parents' gender cognitions play a role in parents' neural processing of gender-stereotype violations by children. Moreover, differences in neural responses toward gender-stereotype violations versus confirmations in children have been found in the domains of toy preference (Endendijk et al., 2019a; Endendijk et al., 2019b) and problem behaviors (Portengen et al., 2022). However, thus far, most studies have focused on parents' neural responses toward the violation and confirmation of gender-stereotyped expectations of unknown children instead of parents' own sons and daughters. Therefore, the primary aim of this study was to examine whether mothers and fathers with a son and a daughter differed in neural responses toward the violation vs. confirmation of gender stereotypes by their own vs. unknown children. A secondary aim was to examine whether this difference depended on parents' own gender, the child's gender, or parents' gendered attitudes.

With regard to the primary aim, expectations were that parents would exhibit stronger ERPs in response to gender violations than confirmations. In addition, two competing hypotheses were tested with regard to the difference between own and unknown children: 1) parents show stronger brain responses (ERP's) to gender-stereotype violations of their own children, than to gender-stereotype violations of other children; 2) parents show less strong brain responses toward gender-stereotype violations of their own children compared to other children. With regard to the secondary aim, we expected that parents' neural responses toward the violation of gender stereotypes would be stronger for boys than girls (both own and other children). Moreover, we expected fathers to differentiate more on a neural level between gender-stereotype confirmations versus violations by both own and other children than mothers. Third, we expected that parents with stronger gender attitudes would show stronger neural responses toward the violation versus confirmation of gender stereotypes of both own and other children.

This study examined gender stereotypes in two domains, namely toy preference and (problem) behaviors. Regarding the former, there is ample evidence that parents and non-parents have strong stereotypical ideas around the appropriateness of toys for boys and girls (e.g., Blakemore & Centers, 2005; Freeman, 2007; Weisgram & Bruun, 2018). For example, parents rate dolls and jewelry as more appropriate for girls, whereas boys are expected to like cars and toy soldiers more than girls (Blakemore & Centers, 2005). The rationale for choosing to include (problem) behaviors was twofold. First, there are clear gender stereotypes about social-emotional behavior, with boys being expected to show more anger and aggression and girls being allowed to show more internalizing emotions, such as sadness and fear (Brody & Hall, 2008). Moreover, parents have explicit gendered expectations about children's behavioral traits, for example expecting girls to be gentle and boys to be noisy (Maccoby & Jacklin, 1974; Martin, 1995). Moreover, the gender-stereotyped expectations associated with these emotions and behaviors have been found to predict later levels of gender-typed problem behaviors in children (Chaplin et al., 2005). The gendered emotions and behavioral traits identified in previous research overlap with the problem behaviors that were included in this study. Second, the behaviors words included in this study have been rated as most male-typed (externalizing) and female-typed (internalizing) behaviors by a group of young adults in a previous study (Portengen et al., 2022). Moreover, in this same study, the combination of child pictures and behavior words have been found to elicit ERP mean amplitude congruence effects in non-parents.

Methods

Participants

Dutch families with a son and a daughter between the ages 3 to 6 years were invited to partake in this study. A total of 74 families were included that consisted of both a mother and a father, with at least one daughter (M_{age} = 4.23, SD_{age} = 1.14) and one son (M_{age} = 4.27, SD_{age} = 1.18) within the target age range, and who had sufficient knowledge of the Dutch language to complete the tasks. This within-family design was used to decrease the possibility that differences in the neural processing of gender-stereotype violations by boys and girls are evoked by other factors than child gender (Endendijk et al., 2018b; McHale et al., 2003). Exclusion criteria were a neurological disease (e.g., Parkinson disease, multiple sclerosis), or a history of epileptic seizures. Data collection took place between August 2020 and June 2022. The sample size was a priori determined based on previous EEG studies with a similar design that recruited between 25 to 60 participants to detect medium effect sizes (Endendijk et al., 2019b; Yang et al., 2020). Because this study included between-person (father, mother) comparisons in its statistical models, 74 families (148 participants) were recruited for this study.

Procedure

Families were recruited through the researchers' personal networks, via information posters at child daycare centers and primary schools, and by using social media advertisements. Parents could express their interest in participating in the study via email or through an online application form, after which they received an information letter containing detailed information about the procedures and privacy regulations of the study. If parents agreed, an appointment was made for a home visit, during which fathers and mothers sequentially underwent EEG examination while performing an Impression Formation Task (IFT). The parent who was not completing the EEG part of the study was participating in an observation study with their son and daughter. Parent gender and EEG task block order were counterbalanced, so that for instance in half of the families, the mother commenced with the EEG examination, and half of these mothers started with the toy preference block, whereas the other half started with the behavior block. Prior to the home visit, parents were asked to upload a picture of their participating son and daughter with a neutral facial expression onto a secured platform (see Supplementary Materials for more information about the instructions provided for parents). These pictures were included in the IFT (see Instruments). Written informed consent was obtained from both parents pre-testing. Parents also gave consent for their participating children. Families received a gift card worth 25 euros for participation and the children received a small gift. Ethical approval was granted by the faculty ethics review board from the Social and Behavioral Sciences faculty at Utrecht University (19-232). This study was not preregistered.

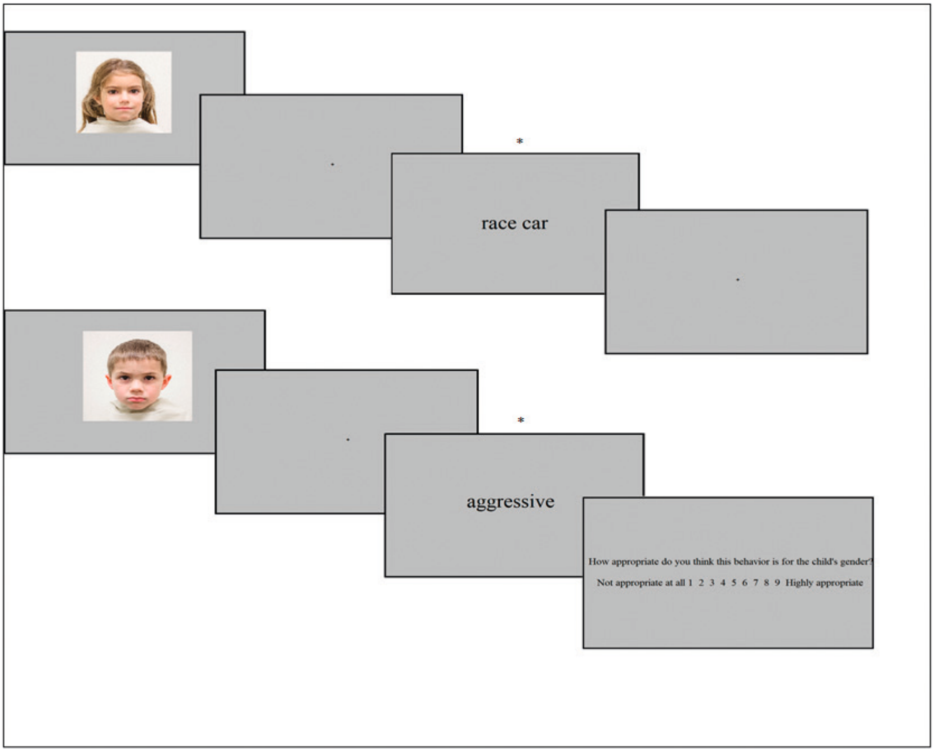
Instruments

Impression Formation Task

The Impression Formation Task used in this study was based on a previously validated IFT task for assessing ERP responses toward gender stereotypes (Portengen et al., 2022). Parents passively viewed 20 pictures of Caucasian children with a neutral facial expression (10 boys, 10 girls) and the pictures of their children (1 son, 1 daughter), which were combined with a word stimulus, and were told to quickly form an impression about the child based on the provided information. The 20 unknown children were selected from the CAFE database (LoBue & Thrasher, 2015) based on who were the most clearly male-typed boys and female-typed girls (Endendijk et al., 2019a). Brightness levels were altered for both the pictures of unknown children and the pictures of parents' own children, so that their mean luminance was between 190 – 205.

After each picture, a toy (block 1) or behavior (block 2) word appeared, respectively describing a toy the child loves to play with, or problem behavior that the child frequently exhibits (see Figure 4.1). The toy word stimuli set contained 10 masculine toy words (crane, tractor, race car, garage, toolkit, soccer, digger, fire truck, pirates costume, helicopter) and 10 feminine toy words (tea set, princess dress, hula-hoop, doll clothes, barbie, play kitchen, jewelry, doll house) that were indicated as clearly masculine and feminine toys in prior studies (Blakemore & Centers, 2005; Endendijk et al., 2014; Endendijk et al., 2019a). The behavior word set contained 20 words derived from the internalizing and externalizing behavior scales from the Child Behavior Checklist (Achenbach, 1999). In this set, 10 externalizing behavior words were selected as describing male-typed behavior (violent, fighting, threatening, kicking, agitated, inattentive, noisy, cruel, disobedient, aggressive) and 10 internalizing behavior words were selected as describing female-typed behavior (dependent, shy, unhappy, depressed, sad, fearful, worried, ashamed, avoidant, sensitive). These behavior words were previously rated as most male-typed and female-typed externalizing and internalizing behaviors, respectively (Portengen et al., 2022).

Figure 4.1. Visual example of Impression Formation Task with the upper representing an incongruent trial without question and the lower representing a congruent trial with appropriateness question.



Note. The asterisk in Figure 4.1 indicates the timing of the trigger signals around which the electroencephalography (EEG) segmentations are constructed.

Each block consisted of 240 trials, 120 trials with unknown children and 120 trials with parents' own children. Each unknown child picture appeared a total of 12 times, 6 times with a word that was congruent with gender stereotypes (e.g., a boy face paired with "race car", a girl face paired with "shy") and 6 times with a word that was incongruent with gender stereotypes (e.g., a boy face paired with "princess doll", a girl face paired with "disobedient"). The words were pseudo-randomly assigned to the unknown child pictures, ensuring no word stimulus appeared twice with the same child face picture. Parents' own child pictures appeared 60 times per block, 30 times paired with congruent words, and 30 times paired with incongruent words. Before each trial, a fixation cross was presented for a varying amount of time (800, 900, 1000, 1100, or 1200 ms, randomly chosen), after which a face picture (1000 ms, width:13.3 cm, height: 9.2 cm) appeared, superimposed in a gray background (191;191;191). A jittered interstimulus interval (ISI) was assigned for 200, 225, 250, 275, or 300 ms, after which the word stimulus was presented in black for

1000 ms (Cambria, font size 55). The word stimuli were trigger coded so that ERPs were segmented around the presentation of the word stimulus.

In half of the trials, a question appeared after the face-word combination (in Cambria font size 24). This question was: "How appropriate do you think this toy/behavior is for the child's gender?". This question was added to retain participants' attention and as a measure of parents' explicit gender attitudes about the appropriateness of the displayed toy and problem behavior words. Participants were instructed to rate the appropriateness of each combination on a scale from 1 (not appropriate at all) to 9 (highly appropriate) by pressing the numbers on the keyboard. The question was presented until the participant pressed a response key (1-9). The task was designed in E-Prime v3.0 (Taylor & Marsh, 2017) and presented electronically on a 14-inch laptop. The task took approximately 40 minutes to complete, depending on how quickly a parent responded to the posed questions and the length of their self-paced break within each block and in between the two blocks (3 breaks in total).

Parents' gender attitudes about children's toy preference and behavior.
Appropriateness ratings of the IFT face-word combinations were extracted and used as a measure of parents' level of gender attitudes about toy preference and problem behaviors. Gender attitudes about toy preference were calculated by subtracting the average appropriateness scores on incongruent trials during the toy block from the average appropriateness scores on congruent trials during the toy block (Portengen et al., 2022). The same scores were calculated for parents' gender attitudes about problem behavior. A higher positive score meant that parents rated stereotype-congruent child-toy or child-behavior combinations as more appropriate than stereotype-incongruent child-toy or child-behavior combinations.

Electroencephalographic measurement and preprocessing

BioSemi ActiveTwo Ag-AgCI pin electrodes and hardware was used to record EEG from 32 scalp sites (BioSemi, 2011). The electrodes were positioned using the 10-20 electrode system using a nylon electrode cap (Klem et al., 1999). EEG signals were sampled at 2048Hz, amplified, and bandpass filtered at DC-400Hz. Eye movements were recorded by placing four sintered Ag-AgCI electrodes above and below the left eye and just outside the outer corner of each eye.

EEG data were offline downsampled to 256Hz sampling rate, followed by bandpass filtering of 0.1 – 30Hz. Each parent's data were re-referenced to the average activity in all channels. The Gratton and Coles method was applied to correct for ocular artifacts (Gratton et al., 1983). Data were cut into segments of -200 to 1000ms, time-locked to the onset of the word stimuli. A baseline correction of -200 to 0 ms was applied to correct for baseline differences in voltage and drift between trials and electrodes. Artifacts rejection was done semi-automatically, which meant that trials were marked as bad if the voltage step exceeded 50 uV/ms, with a maximum allowed difference of 1000 uV in intervals within a 200ms window, or with activity in intervals below 0.5 uV. Bad trials were visually inspected and discarded if the artifact was present across two or more electrodes, or in one of the electrodes of interest. A channel was discarded from preprocessing and further analysis for that participant if artifacts were presented in more than 25% of the trials and if this was not one of the electrodes of interest. Participants were excluded when they had significant noise in one of the electrodes of interest or when there were less than 10 valid trials included in the average segments. The remaining data for each participant was averaged into one grand average waveform per condition. Total average waveforms were created from each participant's grand average waveform. These waveforms were visually inspected to select time windows and electrodes for the ERP components of interest. The electrodes and time windows with the largest amplitudes were selected, see Table 4.1 for an overview of the time windows and electrodes per condition and Figure 4.2 and 4.3 for the grand average waveforms, separate for each block (toy and behavior).

Table 4.1. Overview of the time windows and electrodes for the event related potentials of interest.

ERPs	time window (ms)	electrodes	similar to ERPs measured in
P1	80 - 135	Pz, P3, P4, PO3, PO4, O1, Oz, O2	He et al. (2009)
N1	135 - 180	Pz, P3, P4, PO3, PO4, O1, Oz, O2	Portengen et al. (2022)
P2	185 - 325	Pz, P3, P4, PO3, PO4	Williams and Themanson (2011)
P3	380 - 500	FC1, FC2 Fz, Cz	Endendijk et al. (2019b)
LPP	450 - 600	P3, P4, PO3, PO4	Breton et al. (2019); Ito et al. (2004)

Note. ERP = event-related potential. LPP = late positive potential.

Figure 4.2. Grand average waveforms during the toy block, separate per child type (upper: unknown; lower: own).

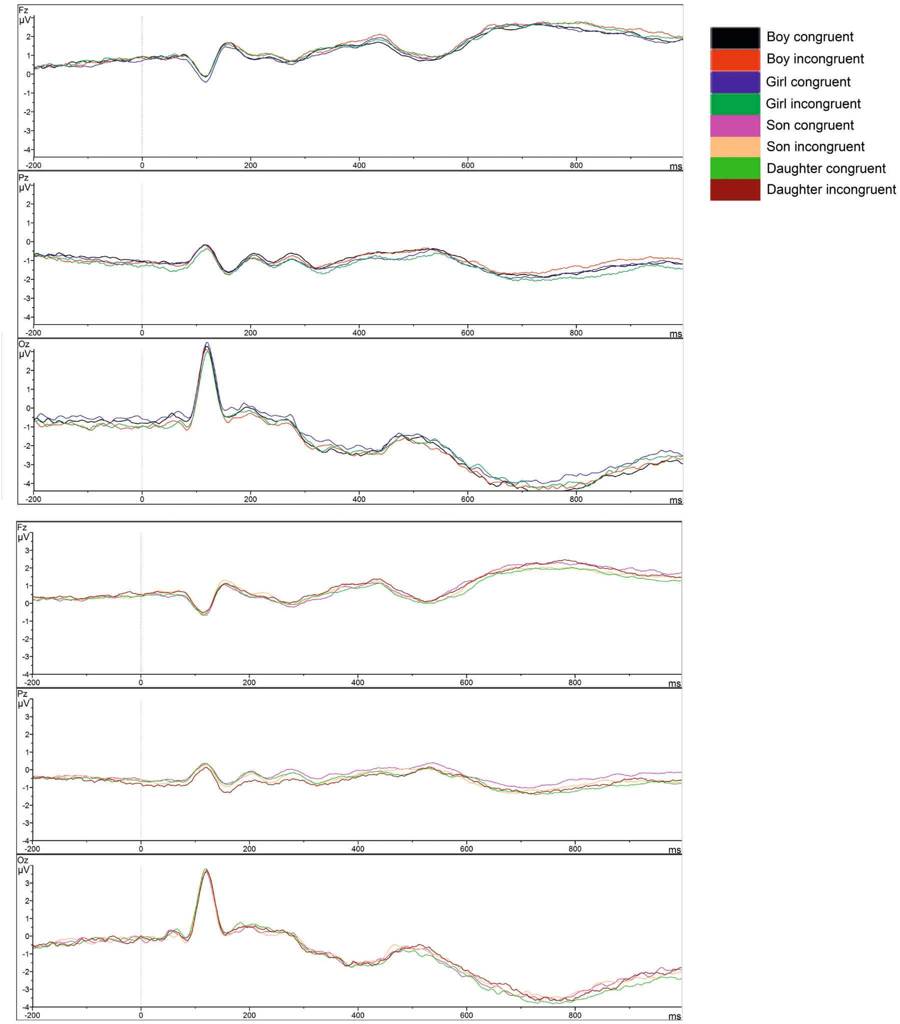
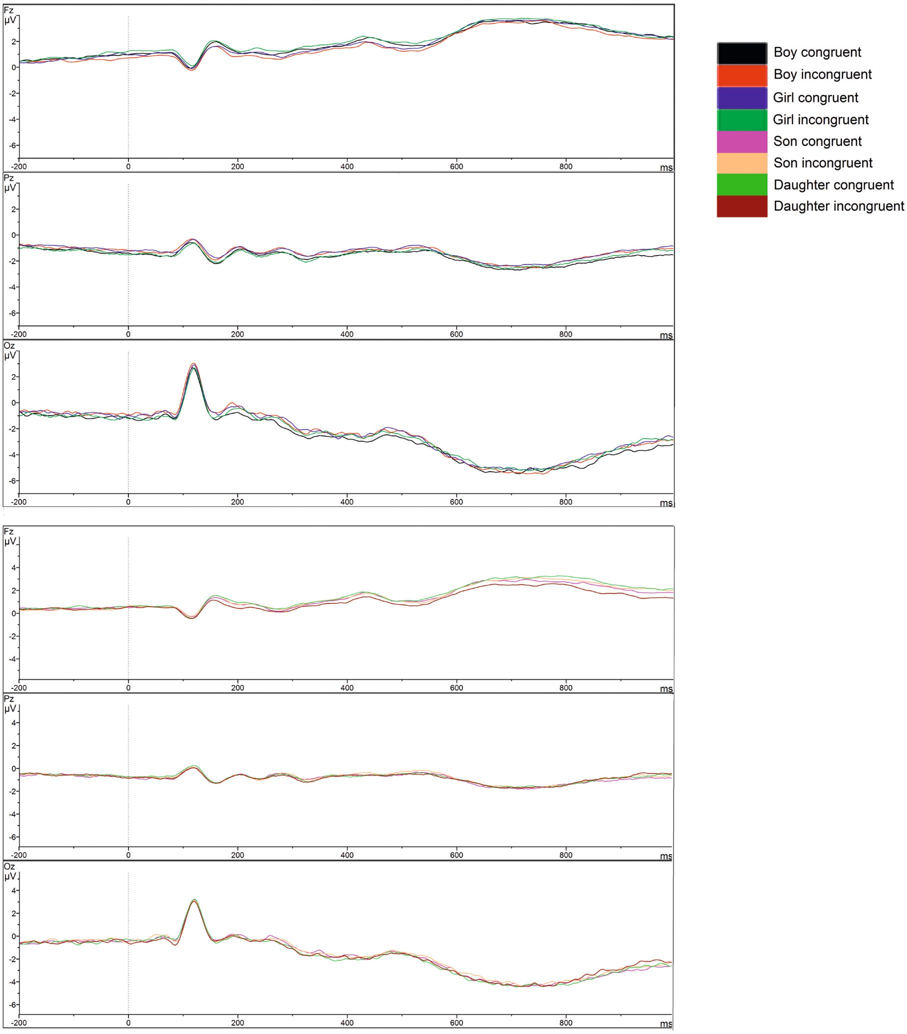


Figure 4.3. Grand average waveforms during the behavior block, separate per child type (upper: unknown; lower: own).



Data analysis

Mean amplitudes per subject and condition were exported from Brainvision Analyzer and imported into R v. 4.2.1 (R Core Team, 2013). Multilevel models were fit by maximum likelihood (ML) using the *lme4* package (Bates et al., 2018). Separate models were run per ERP (P1, N1, P2, P3, LPP) and block (toy, behavior). In these models, ERP mean amplitude was the outcome variable. Since we used fathers and mothers from the same family, parents were nested within families. Since each ERP was measured with multiple electrodes, electrode was nested within the parent. Congruence (congruent/incongruent), child gender (boy/girl), and child type (own/unknown) were added as factors of interest. Parent gender (mother/father), and parents' gender attitudes were added as independent variables if they significantly improved model fit. Moreover, since we were primarily interested in congruence effects, interaction terms were added for congruence and child gender, child type, parent gender, and gender attitudes if these would significantly improve the model fit. Model fit improvement was determined by a significant decrease in the Akaike information criterion (AIC) and Bayesian information criterion (BIC) (Matuschek et al., 2017). Model fits were compared with the *anova* function. Last, to control for Type 1 error rates, the highest order interaction was additionally added as random slope per participant, as recommended by Volpert-Esmond et al. (2021). Degrees of freedom and *p*-values of fixed effects were estimated using the Satterthwaite's method. Residuals and histograms were visually inspected for homoscedasticity and normality of residuals and checked for residual outliers.

Results

Data inspection and descriptive statistics

From the initial 148 parents who participated in this study, nine parents (six mothers) were excluded from further analyses, since no or insufficient EEG data was collected ($n = 5$) or because of noisy data ($n = 4$). For four participants (two mothers), the appropriateness ratings were not saved due to technical problems. This led to the inclusion of 135 parents in the main analyses. Table 4.2 contains an overview of mothers' and fathers' descriptive characteristics. Fathers were on average older than mothers ($p = .018$). Mothers and fathers achieved similar educational levels but significantly differed in their number of paid working hours, with mothers working significantly less hours than fathers ($p < .001$).

Parents rated toy-child combinations that confirmed gender stereotypes ($M = 7.42$, $SD = 0.72$) as more appropriate than toy-child combinations that violated gender stereotypes ($M = 4.54$, $SD = 1.31$; $t(134) = 24.07$, $p < .001$). Similarly, parents rated child-behavior combinations that confirmed gender stereotypes ($M = 4.23$, $SD = 1.12$) as more appropriate than child-behavior combinations that violated gender stereotypes ($M = 3.50$, $SD = 1.08$; $t(134) = 11.58$, $p < .001$). Parents had significantly stronger gender attitudes about toys paired with unknown children ($M = 3.17$, $SD = 1.47$) compared to their own children ($M = 2.73$, $SD = 1.50$; $t(134) = 3.23$, $p = .002$). Similarly, parents held stronger gender attitudes about problem behaviors paired with unknown children (M = 1.14, SD = 0.77) compared to their own children (M = 0.30, SD = 1.15; $t(134)$ = 7.40, p < .001).

Table 4.2. Participant information separate for mothers and fathers.

	Mothers (n = 66)	Fathers (n = 70)	test statistics	p-value
Age, M (SD) [range]	35.83 (3.53) [29 - 45]	37.54 (4.76) [30 - 53]	$t(127)$ = 2.39	.019
Educational attainment, n (%)			$\chi^2(3)$ = 3.53	.317
High school	2 (3.1%)	2 (2.9%)		
Secondary vocational education	12 (18.5%)	20 (28.6%)		
Bachelor's degree	18 (27.7%)	23 (32.9%)		
Master's degree	33 (50.8%)	25 (35.7%)		
Paid working hours, n (%)			$\chi^2(5)$ = 61.57	<.001
No paid working hours	5 (7.7%)	0 (0.0%)		
1-10 hours	1 (1.5%)	0 (0.0%)		
11-20 hours	12 (18.5%)	1 (1.4%)		
21-30 hours	29 (44.6%)	4 (5.7%)		
31-40 hours	17 (26.2%)	55 (78.8%)		
40+ hours	1 (1.5%)	10 (14.3%)		
GAT, M (SD) [range]	3.10 (1.56) [-0.06 – 6.65]	3.13 (1.22) [-0.15 – 5.38]	$t(121)$ = -0.04	.967
GAB, M (SD) [range]	0.72 (0.73) [-0.83 – 2.47]	0.73 (0.73) [-0.82 – 3.00]	$t(132)$ = 0.11	.915

Note. GAT = gender attitudes about toys. GAB = gender attitudes about child problem behavior.

All model residuals revealed no violation of the assumptions of homoscedasticity and normality of residuals. Further examination of the Q-Q plot of standardized residuals revealed one or two outliers (> 5 or < -5) in all but one model (P2 amplitudes during the toy block). Excluding the outliers only led to marginal significance (p = .052) of one higher order interaction between congruence, child gender, and child type on N1 amplitudes during behavior trials reported in the Supplementary Materials.

Parents' neural responses toward the violation of gender stereotypes about toys

Table S1 contains all statistics for the five components during the toy trials. No significant congruence main effects, nor interactions with congruence, were found for any of the ERP components during the toy block (see Supplementary Materials for a more detailed description of findings during the toy block).

Parents' neural responses toward the violation of gender stereotypes about problem behavior

Since there were indications in the N1, P2, and LPP mean amplitudes that congruence effects had carried over from the preceding components, we included the preceding component as a control variable in the models. The uncorrected results can be found in the Supplementary Materials and Table S2. Table 4.3 contains all statistics for the five components during the behavior trials, with N1, P2, and LPP results corrected for the preceding component. Only the congruence effects are listed below as these provided tests of our hypotheses, other findings can be found in the Supplementary Materials. No effects of congruence were found for N1 and P2.

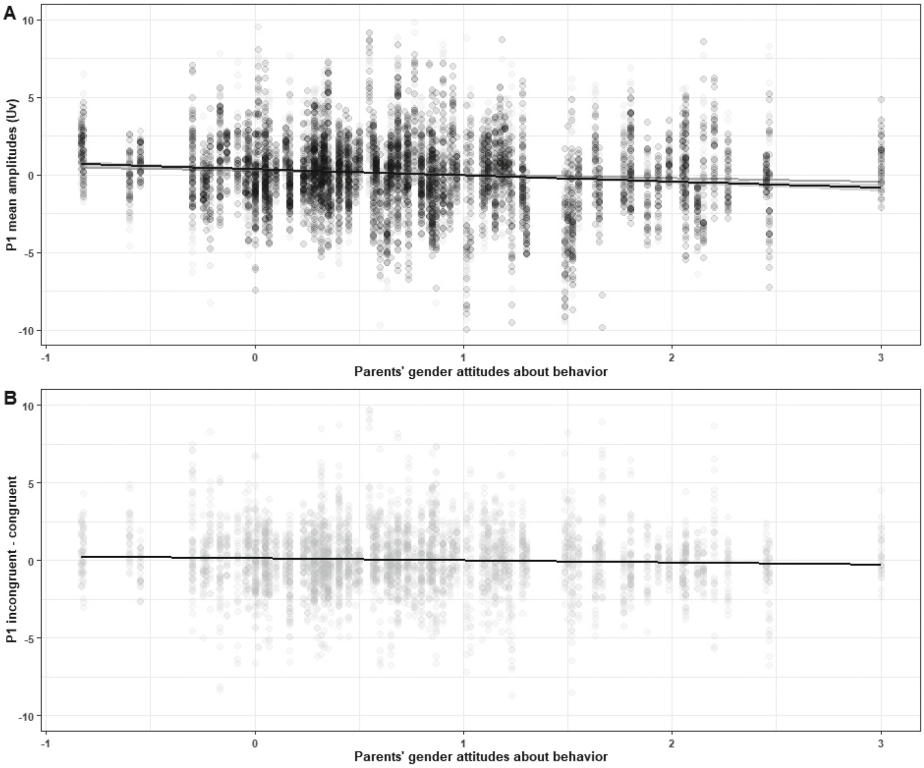
P1

A main effect of congruence (β = .09, $t(135)$ = 3.28, p = .001) and child type (β = .12, t(135) = 4.52, p < .001) was found on P1 mean amplitudes. P1 amplitudes were stronger during incongruent trials than during congruent trials and during trials that contained parents' own children than during trials with unknown children. Moreover, two variables significantly interacted with congruence, namely child gender (β = -.08, $t(135)$ = -3.17, p = .002) and parents' gender attitudes about child problem behavior (β = -.04, $t(135)$ = -2.40, p = .018).

Decomposing the first interaction effect revealed a significant main effect of congruence on boy trials (β = .07, $t(169)$ = 2.52, p = .013). P1 amplitudes were stronger during trials in which boys were paired with internalizing behavior words (incongruent trials) than when boys were paired with externalizing behavior words (congruent trials). This main effect of congruence was not significant for girls (β = -.01, $t(172)$ = -0.46, p = .649).

With regard to the interaction between gender attitudes and congruence, mean amplitudes during incongruent trials were subtracted from mean amplitudes during congruent trials (see Figure 4.4). For parents with stronger gender attitudes about problem behaviors (i.e., rated incongruent behavior as less appropriate for a child's gender than congruent behaviors), their P1 amplitudes toward incongruent trials were larger than toward congruent trials, whereas parents with less strong gender attitudes had larger P1 amplitudes toward congruent than incongruent trials.

Figure 4.4. The effect of parents' gender attitudes about child problem behavior on parents' P1 amplitudes during congruent and incongruent trials. Panel A depicts the separate effects of congruent (black) and incongruent (grey) trials. Panel B depicts the difference in P1 amplitudes during incongruent-congruent trials.



P3

The multilevel analysis with P3 mean amplitudes as a dependent variable revealed a main effect of child type (β = -.08, t(135) = 2.87, p = .005). P3 mean amplitudes were larger during trials that included unknown children than their own children, regardless of which behavior they were paired with. Moreover, two significant two-way interactions were found for congruence, one with child gender (β = .08, t(135) = 2.69, p = .008) and one with child type (β = .06, t(135) = 2.11, p = .036). These two interactions were subsumed under a significant three-way interaction between congruence, child gender, and child type (β = -.12, t(135) = 2.25, p = .026).

Analyses were run separate for own and unknown children. The model with P3 mean amplitudes during trials with parents' own children revealed no main effect of congruence (β = .03, t(135) = 0.96, p = .339) nor was the interaction between congruence and child gender significant (β = -.08, t(135) = -1.22, p = .225). For unknown children, however, a significant interaction between congruence and child gender was found (β = .08, t(135) = 2.69, p = .008). Subsequent analyses revealed that parents had larger P3 amplitudes toward incongruent trials than congruent trials for girls that were not their own children (β = .04, t(135) = 1.65, p = .101), but the reverse was found for boys (i.e., larger P3 amplitudes toward congruent than incongruent trials; β = -.02, t(135) = -1.50, p = .135), although neither association reached statistical significance. In other words, externalizing behavior words elicited larger P3 mean amplitudes than internalizing behavior words when combined with unknown children.

Late positive potential

A significant interaction emerged between congruence and child type (β = .04, t(135) = 2.38, p = .019). Decomposing the interaction effect revealed a main effect of congruence in LPP amplitudes during trials that included parents' own children (β = .05, t(135) = 2.67, p = .008) but this main effect was not found for trials that included unknown children (p = .898). Parents' LPP mean amplitudes were larger during incongruent trials than congruent trials with their own children. Moreover, parents' LPP responses during incongruent trials were larger toward their own children than unknown children (β = .04, t(137) = 3.61, p < .001) but this difference was not found for congruent trials (p = .910).

Sensitivity analysis

To examine whether parents' ERP responses to gendered behavior were representing parents' neural processing of children's actual behavior patterns, zero-order correlations were calculated between the significant ERP mean amplitudes (per condition and per electrode) and parents' reports of their sons' and daughters' internalizing and externalizing behaviors (see Table S3 in the Supplementary Materials). Internalizing and externalizing behavior problems were measured with the 12-item Brief Problem Checklist (Chorpita et al., 2010). Correlations between these variables were low, leading us to assume that other factors than their children's actual behaviors are causing the differential processing.

Table 4.3. Results from the multilevel models examining congruence effects on ERP mean amplitudes during behavior trials corrected for the preceding components.

P1	*b*	*β*	*SE*	*t*(df)	*p*
Congruence	0.53*	.09	.16	3.28 (135)	.001
Child gender	0.17	.03	.13	1.34 (135)	.182
Child type	0.77*	.12	.17	4.52 (135)	<.001
Parent gender	0.19	.03	.31	0.62 (67)	.536
GAB	0.09	.02	.23	0.43 (135)	.670
Congruence*GAB	-0.21*	-.04	.09	-2.40 (135)	.018
Congruence*child gender	-0.60*	-.08	.19	-3.17 (135)	.002
Congruence*child type	-0.33	-.04	.19	-1.73 (135)	.085
Congruence*parent gender	-0.08	-.01	.13	-0.67 (135)	.504
Child gender*child type	-0.09	-.01	.20	-0.45 (135)	.655
Congruence*child gender*child type	0.37	.04	.30	1.22 (135)	.224
N1[a]	*b*	*β*	*SE*	*t*(df)	*p*
Congruence	0.09	.01	.09	1.05 (135)	.296
Child gender	0.07	.01	.06	1.10 (135)	.273
Child type	0.12	.02	.07	1.85 (135)	.065
Parent gender	-0.18	-.03	.17	-1.05 (67)	.297
GAB	-0.26*	-.05	.13	-2.01 (135)	.047
Congruence*GAB	-0.06	-.01	.05	-1.08 (135)	.283
Congruence*child gender	-0.002	-.0002	.09	-0.02 (135)	.987
Congruence*child type	0.12	.01	.08	1.38 (135)	.169
Congruence*parent gender	-0.14	-.02	.08	-1.78 (135)	.078
P2[a]	*b*	*β*	*SE*	*t*(df)	*p*
Congruence	0.03	.01	.09	0.37 (135)	.713
Child gender	-0.09	-.01	.07	-1.21 (135)	.228
Child type	-0.04	-.01	.10	-0.37 (135)	.711
Parent gender	0.13	.02	.13	0.97 (67)	.336
GAB	-0.002	-.0005	.10	-0.02 (135)	.986
Congruence*GAB	-0.001	-.0002	.08	-0.01 (135)	.991
Congruence*child gender	-0.01	-.001	.11	-0.07 (135)	.946

Table 4.3. *(continued)*

P2[a]	*b*	*ß*	*SE*	*t*(df)	*p*
Congruence*child type	0.02	.003	.13	0.17 (135)	.869
Child gender*child type	0.02	.003	.10	0.19 (135)	.852
Child type*GAB	0.23*	.05	.09	2.63 (135)	.010
Congruence*child gender*child type	-0.02	-.003	.16	-0.15 (135)	.885
Congruence*child type*GAB	-0.07	-.01	.12	-0.57 (135)	.569
P3	*b*	*ß*	*SE*	*t*(df)	*p*
Congruence	-0.20	-.04	.14	-1.50 (135)	.135
Child gender	-0.14	-.03	.13	-1.07 (135)	.285
Child type	-0.37*	-.08	.13	-2.87 (135)	.005
Congruence*child gender	0.43*	.08	.16	2.69 (135)	.008
Congruence*child type	0.32*	.06	.15	2.11 (135)	.036
Child gender*child type	0.22	.04	.22	1.00 (135)	.318
Congruence*child gender*child type	-0.83*	-.12	.37	-2.25 (135)	.026
LPP[a]	*b*	*ß*	*SE*	*t*(df)	*p*
Congruence	-0.02	-.003	.10	-0.25 (135)	.801
Child gender	-0.02	-.003	.11	-0.20 (135)	.844
Child type	-0.01	-.002	.13	-0.10 (135)	.922
Congruence*child gender	0.01	.001	.13	0.05 (135)	.963
Congruence*child type	0.37*	.04	.15	2.38 (135)	.019
Child gender*child type	0.23	.03	.18	1.27 (135)	.208
Congruence*child gender*child type	-0.44	-.04	.23	-1.92 (135)	.058

Note. GAB = gender attitudes about child problem behavior. Child type refers to the difference between parents' own children and unknown children. Congruent, boy, unknown child, and father were the reference categories for congruence, child gender, child type, and parent gender, respectively.
[a] Model outcomes are corrected for the preceding component.
The asterisk indicates significant effects with $p < .05$.

Discussion

This study examined whether mothers and fathers showed different neural responses toward gender-stereotype violations and confirmations by their own versus unknown children. Indeed, LPP responses were larger when parents' own children violated gender stereotypes about problem behavior than when parents' own children confirmed these gender stereotypes. Moreover, P1 amplitudes were stronger toward boys who violated gender-stereotyped expectations about problem behaviors than boys who confirmed gender expectations, regardless of whether it concerned parents' own or other children. Additionally, parents with stronger gender attitudes about problem behavior had stronger P1 responses toward children's behaviors that violated gender stereotypes compared to behaviors that confirmed gender stereotypes. Last, there were indications that P3 amplitudes were stronger toward unknown girls paired with externalizing behavior words than unknown girls paired with internalizing behavior words, but stronger toward unknown boys paired with externalizing behavior words than unknown boys paired with internalizing behavior words. Contrary to expectations, no differences were found between mothers' and fathers' neural processing of gender stereotypes, nor effects of gender-stereotype violations regarding toy play.

The current study provided some evidence that parents' neural responses toward gender-stereotype violations were different for their own children compared to unknown children. Stronger LPP mean amplitudes for behaviors that violated gender stereotypes (compared to stereotype-confirmations) were found specifically for parents' own children. LPP responses reflect salience processing and controlled attentional orienting (Brown et al., 2012; Liu et al., 2012) and have also been found to be modulated by the salience of gender stereotypes (Rodríguez-Gómez et al., 2020). Increased LPP mean amplitudes might thus reflect more top-down processing of gender stereotype-violating problem behaviors performed by parents' own children. Parents might respond more strongly toward gender-stereotype violations by their own children because they want to protect them from social exclusion and backlash (Skewes et al., 2018; Sullivan et al., 2018). An important next step is to examine whether LPP responses toward gender-stereotype violations by parents' own children also relate to gender socialization practices with their children. Regarding this, it has been found that parents' neural responses to gendered stimuli of other children are associated with parents' gendered communication with their own children (Endendijk et al., 2019b).

There were also some indications that own and unknown children also evoked different P3 responses; specifically, externalizing behavior words paired with unknown children evoked larger P3 amplitudes than internalizing behavior words. P3 amplitudes have previously been associated with negatively valanced stimuli (Duval et al., 2013; Gyurovski et al., 2018). This may indicate that parents evaluate externalizing behavior as more negative than internalizing behavior when these words were paired with other children.

Notably, we only found differences between own and unknown children on the P3 and LPP components, but not on earlier components. Moreover, the effects we did find for own versus unknown children were small. This could indicate that familial kinship does not play a large role in the neural processing of gender-stereotype violations. Relatedly, parents evaluated unknown children's gender-stereotype violations more negatively than their own children's gender-stereotype violations. Conversely, these findings could indicate that multiple underlying processes, such as individuating information, self-serving bias, or fear of backlash, might simultaneously play a role in parents' processing of gender-stereotype violations by their own children. These factors might cancel out each other's reinforcing or attenuating effects on the neural processing of gender-stereotype violations of own versus unknown children. Future research could aim to disentangle the effects of these underlying processes (individuating information, self-serving bias, or fear of social backlash) on parents' reactions to stereotype-violations by their own children.

With regard to the role of gender of the children, some evidence was found for the hypothesis that gender stereotype-violating boys evoked stronger neural responses than gender-stereotype confirming boys. In line with this hypothesis, P1 mean amplitude responses were larger toward gender stereotype-violating boy-behavior combinations (e.g., boy & depression) than gender stereotype-confirming boy-behavior combinations (e.g., boy & aggression). This is in line with previous research indicating that gender norms are more restrictive for boys than girls (Sandnabba & Ahlberg, 1999; Sullivan et al., 2018). For boys, there is a greater need to avoid feminine behaviors (Vandello & Bosson, 2013). This fits the idea of precarious manhood, which dictates that manhood is something that is earned through the social display of masculine behaviors, whereas womanhood is something biological and does not need to be reinforced (Vandello et al., 2008). In addition, gender-atypical behavior displayed by boys is often heavily penalized and evokes stronger behaviors in adults than gender-atypical display of behaviors by girls (Kane, 2006; Scheibling, 2022).

Some evidence was also found for the hypothesis that parents' gender cognitions played a role in the neural processing of gender-stereotype violations, specifically in P1 mean amplitudes toward congruent and incongruent child-behavior combinations. Parents with stronger gender attitudes about behavior had larger P1 responses toward gender-stereotype violations compared to gender-stereotype confirmations. This interaction between gender attitudes and P1 amplitudes is similar in direction as the study from Portengen et al. (2022), in which adults' P1 amplitudes were modulated by their level of implicit gender stereotypes. However, in the Portengen et al. (2022) study the interaction was found specifically for adults' implicit gender stereotypes and not for gender attitudes. One reason for the differences between these studies is that in the current study, parents' implicit gender stereotypes were not assessed and could not be controlled for. Implicit gender stereotypes and gender attitudes are related constructs (Gawronski & Creighton, 2013; Greenwald et al., 2002). Therefore, part of the relation found between gender attitudes and P1 mean amplitudes in this study could be explained by parents' levels of implicit gender stereotypes. Another, reason for the differences between these studies is that the Portengen et al. (2022) study focused on non-parents, whereas the current study focused on parents. It might be that for parents the attitudes they have about the appropriateness of certain behaviors for boys and girls, plays a more important role in the neural processing of gender-stereotype violations than for non-parents.

Mothers and fathers did not differ in their neural responses toward gender-stereotype violations and confirmations. This contrasts previous literature that found that men and fathers have stronger stereotyped expectations than women and mothers (Endendijk et al., 2013; Proverbio et al., 2018). Interestingly, fathers and mothers also did not differ in their levels of explicit gender attitudes in this study (i.e., how (in)appropriate they rated gender-stereotype violations), which may explain why no differences were found in their neural responses to gender-stereotype violations as well. It confirms other work that found that fathers and mothers also appear to be equally likely to respond negative toward their children's gender nonconforming behaviors (Grossman et al., 2005).

It is also important to note that no differences were found in parents' neural processing of gender-stereotype violations and confirmations regarding children's toy preferences. This replicates previous studies that also did not find any effects of gender-stereotype violations regarding toy preferences on ERP mean amplitudes (Endendijk et al., 2019b; Portengen et al., 2022). The lack of effects in the toy domain could be due to a selection bias in participating families. Although the gendered nature of this study was not advertised explicitly, parents could have easily derived that the study revolved around gender from the information available. Therefore, the participating parents may have been more familiar with and interested in gender-neutral parenting. Several families indeed indicated after the study that they tried to raise their children as gender-neutral as they deemed possible. Gender-neutral parenting often revolves around creating a gender-neutral environment for children (e.g., toy availability, room decorations) (Martin, 2005) and places less emphasis on the development of gendered behaviors. Another explanation for the lack of findings in the toy domain could be the different valences of the word categories used in this study. The behavior words have a stronger negative component and might thus elicit stronger reactions in parents. In general, bad things impact people more strongly than good things (Baumeister et al., 2001; Chen & Bargh, 1999). The words used in the toy block generally have a positive or neutral connotation and might thus be considered less arousing for parents. The negative valence of stimuli is known to elicit more attention allocation as demonstrated by stronger P1 amplitudes (Smith et al., 2003).

Last, the current study did not find differences in parents' N1 and P2 mean amplitudes toward gender-stereotype violations and confirmations. With regard to the lack of findings in the N1 domain, some previous studies have found larger mean amplitude toward (gender-) stereotype violations than confirmations (Dickter & Gyurovski, 2012; Portengen et al., 2022). Nonetheless there are also several studies that report no N1 modulation in response to expectancy violations and confirmations (e.g., Healy et al., 2015; Leuthold et al., 2011). In the current study, N1 mean amplitudes were corrected for the preceding difference in P1 mean amplitudes. When left uncorrected for the previous peak, N1 amplitudes were modulated by interactions between gender attitudes and congruence (stronger N1 differences when parents had more traditional gender attitudes about behavior) and child gender and congruence (congruence effect found for boys but not girls, with larger amplitudes during congruent than incongruent trials). It is possible that some of the N1 effects observed in previous studies may have been carry-over effects from P1 mean amplitude differences. The lack of findings in P2 mean amplitude modulations is not surprising considering the inconsistent findings from previous research (Jerónimo et al., 2017; Portengen et al., 2022; Yang et al., 2020). Our results thus might indicate that the P2 appears to be a less reliable indication of gender stereotyping in the brain.

Despite the strengths of the large sample size and within-family design, the study also comes with some caveats. First, the sample consisted mainly of highly educated, White families. Therefore, the conclusions drawn from this study can only be generalized to this population. Moreover, only mixed-gender parent-couples were included in this sample. This ensures that the results from this study would not be confounded by other factors than child gender, but this also limits the generalizability of findings. Third, even though pictures of parents' own children were adjusted in luminance range, the quality of pictures varied per family. It might be that the (lack of) effects for own- versus unknown-child are due to differences in lighting composition and/or quality of the provided pictures. Future studies might control for these factors by standardizing the picture setting for parents' own children by having the researchers take pictures.

The results of this study provide several directions for future research. First, this research only examined gender stereotypes in the domain of toy preference and problem behaviors. Other domains, such as emotions, math abilities, or occupational preferences, are also highly gendered (Brody & Hall, 2008; Gunderson et al., 2012; Root & Rubin, 2010; Wang & Degol, 2017). Future research could examine whether the results found in this study can be extended to these other gender-stereotype domains for children of different ages. Second, it would be interesting to investigate if parents' neural responses to gender-stereotype violations by their own children are related to actual gendered parenting behaviors and emotion socialization practices (van der Pol et al., 2015) in the home context, since gender-stereotype violations by parents' own children evoke different neural processes than unfamiliar children. Third, the congruence effect found in LPP amplitudes that was specific for own children warrants future research to investigate the underlying mechanisms that can explain which motivational process underlies this top-down processing strategy.

Conclusions

This study indicated that parents differentiate in the processing of gender-stereotype violations by their own and unknown children, and between boys and girls, specifically when problem behavior is described. Importantly, kinship between parent and child appeared to enhance the neural but reduce the evaluative reactions to gender-stereotype violations. Furthermore, the increased neural processing of gender-stereotype violations could partly be linked to parents' more negative evaluations of gender-stereotype violations. Since gender-stereotype violations in the domain of problem behavior still evoke clear neural and evaluative reactions in parents, it may be especially important to make parents more aware of their stereotyped expectations of their children's behaviors. Therefore, more research into parents' neural processing of gendered information about their children as an underlying process of parents' gender socialization strategies is warranted. The socialization of less rigid gender norms for child behavior can help future generations of children, and especially boys, to be able to express more gender-atypical behaviors and pursue (academic) careers often deemed gender atypical.

5

Gender-differentiated emotion socialization: Evoked by child behaviors or driven by parents' neural responses toward gender-stereotype violations?

Christel M. Portengen[a], Anita Harrewijn[b], Anneloes L. van Baar[a], & Joyce J. Endendijk[a]
[a] Clinical Child and Family Studies, Utrecht University, Utrecht, the Netherlands
[b] Department of Psychology, Education & Child Studies, Erasmus University Rotterdam, Rotterdam, the Netherlands

This chapter is submitted for review.

Abstract

During early childhood, gender differences in behavior and emotional expressions become more prominent. Parents' gender-differentiated socialization is thought to explain part of these different trajectories in behavioral and emotional development. It remains unclear whether parents' gender-differentiated socialization is driven by processes within parents, evoked by children's own behaviors and emotions, or by reciprocal processes. This study examined whether parents' gender labelling of emotional characters could be predicted by (1) parents' neural responses to gender-stereotype violations and confirmations by their own children or (2) their children's behavior and emotional expressions. Home visits were conducted with 74 families consisting of a father, mother, and a son and daughter aged 3-6 years old. Electroencephalography measurements were obtained from parents while they passively viewed pictures of their son and daughter combined with gender-typed behavior and emotional expression words. Mothers' and fathers' use of gender labels was coded while they read a picture book to their son and daughter in which gender-neutral child characters were displaying sadness, fear, and anger. Children's gender-typed behavior and emotional expressions were measured through parent-report of the Brief Symptom Checklist. Multilevel models revealed some evidence for the role of parents' P1 mean amplitudes elicited by pictures of sons and daughters combined with internalizing expression words in their use of gender labels for the fearful characters. No relations were found between parents' use of gender labels and children's behavior and emotional expressions. These findings on gender socialization are discussed in light of previous findings and the gender-neutralizing effect of mixed-gender siblings.

Introduction

For decades, there has been a scientific and societal debate about the roots of gender differences in social and emotional behaviors (DeCecco & Elia, 1993; Stewart & McDermott, 2004). Essentialist thinkers argue that men and women represent distinct dichotomous categories and develop different preferences and behaviors due to innate differences in for instance hormonal processes and developmental trajectories (Gelman, 2003; Irvine, 1990; Meyer & Gelman, 2016). On the other side of the discussion are scholars studying how socialization practices and societal pressure to conform to gendered norms contribute to the development of gender-typed emotions and behaviors in children and adults (Biever et al., 1998; Blakemore et al., 2008; Fagot & Leinbach, 1993; Lorber & Farrell, 1991). There is a need for more research on the differential biological and social processes contributing to the development of gender differences in behavior and emotional expressions to support optimal functioning of children and adolescents regardless of gender (Berenbaum et al., 2011).

Parents are important socializing agents for children in early childhood. Parents' differential socialization of boys and girls has been found to partly explain gender differences in aggressive and emotional behavior (Chaplin et al., 2005; Endendijk et al., 2017; Root & Rubin, 2010). Because of the consequences of gender-differentiated socialization for children's behavioral and emotional development, it is important to investigate which underlying factors contribute to gender-differentiated parenting. Recently, parents' neural responses toward gender-stereotype violations were found to be a more robust predictor of parents' gender-differentiated socialization practices than their level of explicit or implicit gender stereotypes (Endendijk et al., 2019b). Therefore, the current study examined whether parents' gender-differentiated socialization is driven by their neural responses to gender-stereotyped information, and/or evoked by children's behavior and emotional expressions. This would shed light on to what extent differential treatment of sons and daughters is driven by processes within the parent or evoked by gender differences in the behavior and emotional expressions of sons and daughters.

Parental gender-differentiated emotion socialization

There are several domains in which parents can apply gender-differentiated parenting. One of these domains is parental emotion socialization, which refers to the ways in which children learn about their own and others' emotions through their parents' behaviors and responses to children's emotions (Eisenberg et al., 1998). This process is fueled by parents' beliefs and attitudes about (the appropriateness of) emotions (Baker et al., 2011; Cassano

& Zeman, 2010). Parents can employ several types of emotion socialization, namely: verbally or nonverbally reacting toward children's emotions, discussing emotions with their children, and expressing their own emotions.

Moreover, parents' emotion socialization seems to differ depending on their own and their 3-year-old child's gender, which has consequences for children's social-emotional behaviors at age 4 (van der Pol et al., 2016). For example, parents' lax parenting was positively related to preschool boys' and girls' gender stereotype-confirming behavior and emotional expressions (externalizing for boys, internalizing for girls) while overreactive parenting was related to more gender stereotype-violating behavior and emotional expressions (Kim et al., 2005). In addition, sons' and daughters' gender stereotype-violating behaviors and emotions elicited more dismissing comments than children's gender stereotype-confirming behavior and emotional expressions in middle childhood (Cassano & Zeman, 2010). In particular, during observations parents paid more attention to 4-year-old boys and girls displaying gender-stereotype-confirming emotions (e.g., anger for boys, sadness/anxiety for girls) than gender-stereotype violating emotions (Chaplin et al., 2005). In this study, parental attention was broadly defined as parents' verbal, behavioral, or emotional responses (either negative, neutral, or positive) toward their child's display of emotions. Importantly, in this study parental attention to children's sadness and anxiety also predicted internalizing behavior and emotional expressions in children at the age of 6 years (Chaplin et al., 2005).

Regarding conversations about emotions, parents have been found to talk more elaborately about sadness and fear with their preschool daughters than with their preschool sons (Fivush et al., 2000; Fivush & Buckner, 2000). Moreover, during picture book reading with their preschool children, parents are more likely to label angry gender-neutral child characters as boys, and sad or happy gender-neutral child characters as girls (van der Pol et al., 2015), thereby confirming gender stereotypes about emotions. In the current study, this specific type of emotion socialization was further examined. The current study extends previous research on gender-differentiated emotion socialization by examining whether differential socialization of son's and daughter's emotions could be explained by child-centered factors (e.g., sons' and daughters' behavior and emotional expressions) and/or by parent-centered factors (i.e., parents' neural processing of gender-stereotype violations and confirmations).

Gender-differentiated parenting in relation to child behavior and emotional expressions

Sons and daughters might elicit gender-differentiated emotion socialization from parents depending on gender differences in behavior and emotional expressions. Most of the studies that examined the relations between parental emotion socialization and child characteristics have used cross-sectional datasets (Fivush et al., 2000; Fivush & Buckner, 2000; van der Pol et al., 2016). In these studies, only a link between gender-differentiated emotion socialization and child behavioral and emotional functioning can be established, but the directions remain unclear. The importance of reciprocity within parent-child dyads is emphasized in theoretical frameworks of child development (Bell, 1979) but it is often not accounted for in research examining gender-differentiated emotion socialization. Yet evidence exists that child fearfulness also elicits parenting behaviors that reinforce these behaviors, such as overprotective parenting (Kiff et al., 2011). Therefore, this reciprocity might also entail that when a parent's daughter expresses more internalizing behavior and emotions than their son, parents might learn to associate internalizing emotions and behaviors more with girls than with boys (Bem, 1981, 1983; Martin & Halverson, 1981). Consequently, when they talk to their children about emotions they might ascribe internalizing emotions (e.g., sadness) more often to girls than boys. Although infants do not yet show gender differences in their emotional reactivity (Else-Quest et al., 2006), preschool boys and girls do show distinct patterns of emotion expression, with boys expressing more anger and girls being more likely to express fear and sadness (Chaplin & Aldao, 2013). Moreover, gender difference in problem behavior and emotions emerge at an early age, with boys showing more aggression and girls showing more internalizing problems such as sadness and anxiety (Zahn-Waxler et al., 2008).

Parents' gendered expectations of child behaviors

In contrast, gender-differentiated emotion socialization might also originate from processes within the parent. When children express emotions that are considered inappropriate for their gender, children might violate parents' gendered expectations. According to gender schema theories (GSTs) (Bem, 1981, 1983; Martin & Halverson, 1981), parents have gender schemas that contain gender-related information. These gender schemas provide parents with social standards that guide their (parenting) behaviors. According to the GSTs, individual differences in the extent to which parents apply gender-differentiated emotion socialization can be explained by the strength of parents' gender cognitions.

Accordingly, evidence exists that parents' gendered cognitions are related to the ways in which parents teach their children about gender (i.e., gender socialization) (Portengen et al., 2023). Parents who endorse traditional gender stereotypes have been found to emphasize gender stereotypes more through their language use or toy purchases than parents with egalitarian gender stereotypes (Endendijk et al., 2014; Friedman et al., 2007; Weisgram & Bruun, 2018). Importantly, Endendijk et al. (2017) found that fathers with more traditional gender stereotypes used more physical discipline strategies with boys than girls, whereas for fathers with counter-stereotypical gender beliefs the reverse was observed, even when controlling for initial levels of child aggression. Thus, it seems that parental gender stereotypes play a pivotal role in parents' use of gender socialization toward their sons and daughters. Because of the often implicit nature of gender stereotyping and social desirability issues that play a role when examining gender stereotyping in adults, neuroscientific measures have been found to be a better predictor of gender socialization than self-report measurements of gender stereotypes (Endendijk et al., 2019b; Greenwald et al., 2002; Greenwald & Krieger, 2006). Therefore, the current study examines parents' neural processing of gender-stereotype violations in relation to parents' gender-differentiated emotion socialization.

Neurocognitive processes underlying gender-differentiated parenting

Many studies examining neural processes underlying (gender) stereotyping have administered an Impression Formation Task (IFT) and compared neural responses toward expectancy-violating (e.g., a sad boy) and expectancy-confirming trials (e.g., an angry boy) (Dickter & Gyurovski, 2012; Endendijk et al., 2019a; Portengen et al., 2022; Rodríguez-Gómez et al., 2020). In these studies, several components of interest are identified that might be related to parental gender socialization (Portengen et al., 2023). First, previous research has found that gender-stereotype violations elicited larger P1 mean amplitudes than gender-stereotype confirmations (Liu et al., 2017; Portengen et al., 2022). The P1 is associated with early attentional processing and reflects the earliest stages of information processing (Di Russo et al., 2003). In addition, the late positive potential (LPP) component is a measure of motivational salience (Hajcak et al., 2009) and has been found to be larger toward either gender-stereotype violations or confirmations (Liu et al., 2017; Osterhout et al., 1997). Moreover, LPP amplitudes have been found to differ depending on the salience of gender stereotypes (Rodríguez-Gómez et al., 2020).

However, only a few studies have related parents' neural responses toward gendered information to actual (parenting) behaviors. First, Mascaro et al. (2017) found in their fMRI study that fathers of daughters had elevated medial and lateral orbitofrontal cortex (OFC) activity toward their daughters' happy faces whereas fathers of sons had elevated medial OFC responses toward their sons' neutral faces. Moreover, medial OFC activity toward happy faces was negatively associated with time fathers spend in rough-and-tumble play, whereas medial OFC activity of fathers of sons toward neutral faces was positively related to rough-and-tumble play specifically in fathers of sons. The OFC has previously been implicated in reward processing (Rolls et al., 2020) with the medial OFC activity specifically responsible for reward value monitoring (Kringelbach, 2005; Kringelbach & Rolls, 2004; O'Doherty et al., 2003).

Second, Endendijk et al. (2019b) found in their electroencephalography (EEG) study that differences in mothers' N2 and P3 amplitudes were related to the way in which mothers conveyed gender-stereotyped information to their children. Mothers with stronger N2 or P3 responses toward gender stereotype-violating than gender stereotype-confirming stimuli evaluated gender stereotype-violating pictures as more negative during picture book reading than gender stereotype-confirming pictures (Endendijk et al., 2019b). The N2 is thought to reflect conflict monitoring (Azizian et al., 2006) and the P3 is assumed to be an index of stimulus-evoked surprise and has been associated with attention to unexpected events (Polich, 2007). In sum, these studies provide indications for the role of parents' neural processing of gendered information in the ways in which parents utilize gender-differentiated parenting practices. However, no studies to date have examined whether these neural processes are also related to gender-differentiated emotion socialization in particular.

5

Current study

In sum, gender differences in child behavior and emotions and parents' gender-differentiated emotion socialization seem to be related and there is preliminary evidence for a link between parents' neural responses to gender-stereotyped information and their (gender-differentiated) socialization practices. The current study now examined whether parents' gender-differentiated emotion socialization is related to gender differences that parents observe in their son's and daughter's emotions and behavior or whether gender-differentiated emotion socialization is driven by neural processes underlying gender stereotyping within parents. This study was performed in the Netherlands, a country that scores relatively high on worldwide indices of gender equality (European Institute for Gender Equality, 2020). Additionally, gender-role attitudes are more egalitarian and child care and paid work is more equally divided among parents than in other (Western) countries (Fortin, 2005).

The following hypotheses were formulated. First, it is expected that parents who are more likely to label sad, scared, and angry children in accordance with gender stereotypes (boy=angry, girl=sad/scared):

a) show smaller neural mean amplitude responses (P1, P3, LPP) toward gender stereotype-confirming and larger neural mean amplitude responses toward gender stereotype-violating stimuli depicting child problem behaviors (Endendijk et al., 2019b; Portengen et al., 2022) and/or
b) are more likely to have a son and daughter whose behavioral and emotional expressions are gender-typical (i.e., more internalizing expressions in daughters, more externalizing expressions in sons) (Cassano & Zeman, 2010; Endendijk et al., 2018).

Similarly, it is expected that more stereotype-incongruent gender labeling by parents (boy=sad/scared; girl=angry) is related to:

a) larger neural mean amplitudes toward gender stereotype-confirming and smaller mean amplitudes toward gender stereotype-violating child stimuli and/or
b) more gender-atypical behavioral and emotional expressions of parents' own sons and daughters.

Materials & methods

Participants

A total of 74 Dutch families (148 parents; 96.6 White, 2.0% Asian, 1.4% other ethnicity) were recruited based on the following selection criteria. Families had to consist of a mother, father, and (at least) one son and one daughter between the ages 3-6 years. Exclusion criteria were insufficient knowledge of the Dutch language, a history of epileptic seizures, or neurological diseases in parents or children. In 33 families, the participating daughter was older than the son; in 32 families, the son was the oldest of the participating children; and in nine families, daughter and son were twins. Participant recruitment and testing took place from August 2020 until June 2022. Although parents who were separated were eligible to participate, all participating parents were living together at the time of data collection.

Procedure

Home visits were conducted with families that were recruited via researchers' personal networks, child day care centers and primary schools, and through social media advertisements. If parents expressed their interest in participating, via email or through an online application form, they were sent an information letter containing detailed information about the procedures of the study. When both parents agreed to participate, an appointment was made for a home visit.

During the home visit, parents subsequently underwent EEG examination and participated in an observational study with their son and daughter. The order in which parents started with the EEG examination or observational study was counterbalanced, so that half of the mothers and half of the fathers commenced with the EEG examination. After parents had completed both the EEG and observation tasks, they filled out an online survey consisting of several questionnaires. Families received a gift card worth 25 euros for participating and the children each received a small gift. Written consent was obtained for both parents prior to testing. Parents also gave consent for their children. Ethical approval was obtained from the faculty ethics review board from the Social and Behavioral Science faculty at Utrecht University (19-232).

EEG procedure

Parents were positioned in a separate room for the EEG task. BioSemi ActiveTwo Ag-AgCI pin electrodes and hardware (BioSemi, 2011) were used to obtain EEG measurements from 32 scalp sites whilst parents performed an IFT (see Measures).

Observation procedure

The parent who was not undergoing EEG examination, was participating in the observation tasks with their son and daughter. Fathers and mothers were handed one of two versions of a picture book (see Measures) and were instructed to discuss the pictures with their children. Time allotted for the book reading was 15 minutes, but parents could finish earlier. Parents received a signal when two minutes of reading time remained. Regardless of whether parents exceeded the time limit of this task, they were instructed to finish the book and all data were coded. Picture book reading by the parents was videotaped and coded afterwards by the first and last author.

Measures

Impression Formation Task

The IFT used in this study has been described in detail elsewhere (Portengen et al., 2022). Data from the IFT's behavior and emotional expressions block were used for this study. In short, parents passively viewed 20 pictures of unknown Caucasian children (10 boys, 10 girls; width: 13.3 cm, height: 9.2 cm) with a neutral facial expression from the CAFE database (LoBue & Thrasher, 2015) and pictures of their own son and daughter (width:

13.3 cm, height: 9.2 cm) who participated in this study. For the current study, only the neural responses toward pictures including parents' *own* children were used, since these are presumed to be most related to the ways in which parents socialize their children. All pictures had a mean luminance within the range of 190-205. These pictures were combined with 10 externalizing words (violent, fighting, threatening, kicking, agitated, inattentive, noisy, cruel, disobedient, aggressive) representing male-typed behavior and emotional expressions and 10 internalizing words (dependent, shy, unhappy, depressed, sad, fearful, worried, ashamed, avoidant, sensitive) representing female-typed behavior and emotional expressions, derived from the Child Behavior Checklist (Achenbach, 1999). These words were rated as most male-typed and female-typed in a previous study (Portengen et al., 2022).

Within 120 trials, parents' own children were paired 30 times with gender stereotype-congruent words and 30 times with gender stereotype-incongruent words. Children's pictures (1000ms) appeared after jittered fixation cross (800, 900, 1000, 1100, or 1200ms, randomly chosen) and were presented with a grey background (191;191;191). After a jittered interstimulus interval (200, 225, 250, 275, or 300ms, randomly chosen), the word stimulus was presented in black (Cambria, font size 55) for 1000ms. In half of the trials, parents were asked to rate the appropriateness of the child and behavior and emotional expression combinations on a scale from 1 (not appropriate at all) to 9 (highly appropriate) by pressing the numbers on the keyboard. This question appeared until parents pressed a response key.

Gender labeling during emotion talk

Each parent was asked to read a picture book with their son and daughter. This picture reading book was adapted from previous studies on gender and emotion talk (Endendijk et al., 2014; van der Pol et al., 2015) and contained twenty drawings of children performing activities, prosocial and antisocial behavior, or expressing emotions. The original picture book contained 8 drawings of gender-neutral emotional characters displaying 4 emotions, namely anger, fear, sadness, and happiness. Each emotion was displayed twice; once with and once without contextual information (e.g., an angry child in a store, a fearful child on a slide). These pictures were validated in a previous study and were able to elicit correct labeling of the emotion (van der Pol et al., 2015). Moreover, it was checked whether facial characteristics unrelated to the expressed emotion could have elicited gendered labeling, which was not the case (van der Pol et al., 2015). The child characters moreover were validated as gender neutral in another study (Endendijk et al., 2014).

For the current study, only three drawings of gender-neutral children were used showing fear, sadness, and anger without contextual information. During the preschool years, gender differences in the expression of these three basic emotions emerge (Chaplin & Aldao, 2013). Moreover, these basic emotions are best recognized by children in comparison to other emotions (e.g., de Bordes et al., 2021; Porter et al., 2021). The current study only focused on those emotions that were included in the EEG measurements and could be directly linked to internalizing and externalizing behavioral and emotional expressions, thus excluding the happy pictures. In addition, the pictures with contextual information elicited highly unexpected gender labeling results, leading to the decision to exclude these pictures. More specifically, in the pictures with contextual information, children were dressed in clothes that could be considered male-typical (e.g., wearing pants, wearing swimming pants). This was also detectable in the data: all contextual information pictures elicited significantly more use of label 'boy' to identify the emotional child characters (*p*s < .001). Therefore, we concluded that the context provided information about the children's gender and thus we excluded the child character drawings with contextual information[1]. Since mothers and fathers performed this task separate of one another, but with both their children, two versions of the picture book were created with similar looking gender-neutral children in the pictures (only color of hair and clothing differed between books) displaying the same emotions across the books.

The gender labeling coding system as described in van der Pol et al. (2015) was used to measure parents' use of gender labels when discussing the emotion pictures with their children. Parents' use of male (e.g., boy, man, he, his, Peter) and female labels or pronouns (e.g., girl, woman, she, her, Linda) for the child in the pictures was coded by the first and last author as either absent (0) or present (1). Coders were allowed to code both mother and father observation data from the same family (n = 9) as coding was a straightforward indication of if parents did or did not use a gender label to describe the character of the child in the picture. A reliability set of 25 film fragments was coded by both the first and last author, with excellent agreement between the two coders (κ = .826 for male labels and κ = .896 for female labels). The picture book was read in the language that parents preferred to communicate with their children with. For all but two parents (1 Frisian, 1 German), this language was Dutch. Film fragments of the non-Dutch speaking parents were double-

1 Analyses in which happy child pictures and pictures with contextual information were included revealed no significant effects for parents' neural responses elicited by their son's and daughter's behavior and emotional expressions, nor children's parent-reported levels behavior and emotional expressions.

coded by both the first and last author who were sufficiently proficient in both languages to understand the conversation and determine the use of gender labels in the film fragments.

Brief Problem Checklist

The Brief Problem Checklist (BPC) was used as a parent-report measurement of children's internalizing and externalizing emotions and behaviors (Chorpita et al., 2010). The internalizing and externalizing scales each consisted of 6 items each, rated on a scale from 0 (never) to 2 (often). Parents were asked to rate how often their children expressed these 12 types of behaviors and emotions in the preceding two months. The BPC has moderate to good internal consistency and reliability, and demonstrated convergent and discriminant validity (Chorpita et al., 2010). The BPC has been used as a parent-report measurement of child internalizing and externalizing behaviors and emotions at various ages, including early childhood (Brassell et al., 2016; Parent et al., 2016; Sanders et al., 2016). The internal consistency in the current sample was acceptable, with Cronbach's alpha ranging from $\alpha = .655$ (daughter internalizing) to $\alpha = .772$ (son internalizing). Average scores were calculated per subscale as a measure of son's and daughter's internalizing and externalizing behaviors and emotions. Since both mothers and fathers filled out the BPC for each child, parents' scores were averaged. Table S1 depicts the correlations between the father and mother reports of their son's and daughter's levels of internalizing and externalizing behaviors and emotions.

Electroencephalography preprocessing

Electroencephalography preprocessing was done in accordance with a previous study that administered an identical task using Brainvision Analyzer (Portengen et al., 2022). To summarize, EEG data were offline downsampled to 256Hz, bandpass filtered (0.1-30Hz), and referenced to the average activity of all electrodes. Data were corrected for ocular artifacts using the Gratton & Coles method (Gratton et al., 1983) and subsequently segmented -200ms to 1000ms around the onset of the behavior and emotion word stimuli with a baseline correction of -200ms to 0ms. Artifact rejection was performed semi-automatically, with trials marked as bad if the voltage step exceeded 50 uV/ms, with a maximum allowed difference of 1000 uV in intervals within a 200ms window, or with activity in intervals below 0.5 uV. Bad trials were discarded if the artifact was present in one of the electrodes of interest or across two or more electrodes. A channel was excluded from further preprocessing if artifacts were present in more than 25% of the trials and it was not an electrode of interest. Participants with less than 10 valid trials per condition were excluded from further analyses. The remaining data were averaged into grand average waveforms per condition per participant and subsequentially averaged into total average waveforms across participants.

ERP components were selected on the basis of previous research examining neural correlates of gender socialization (Endendijk et al., 2019b) and were sensitive toward gender-stereotype violations in a previous study (Portengen et al., 2022). One component of interest (N2) as identified by Endendijk et al. (2019b) was not clearly detectable in this data and was thus omitted from further analysis. This is not uncommon, since other studies that applied an IFT paradigm to examine the neural processing of gender stereotyped information also did not detect clear N2 mean amplitudes whilst participants were performing an IFT (Portengen et al., 2022). For the P1, mean amplitudes were calculated from occipital-parietal electrodes (Pz, P3, P4, PO3, PO4, O1, Oz, O2) with a time window of 80-135ms (He et al., 2009). For the P3, frontocentral electrodes were selected (FC1, FC2, Fz, Cz) with a time window of 380-500ms to obtain mean amplitudes (Endendijk et al., 2019b). Last, the LPP mean amplitude was measured within a time window of 450–600ms and contained occipital-parietal electrodes (P3, P4, PO3, PO4) (Breton et al, 2019; Ito et al., 2004). Components and time windows were selected based on earlier work on this data (Portengen et al., 2022).

Data analysis plan

As part of descriptive statistics, correlations were computed between the variables of interest. In addition, to examine differences between fathers and mothers on the study variables t-tests for dependent samples and chi-square tests were used.

To examine whether parents' stereotype-congruent and stereotype-incongruent gender labeling of child emotions could be predicted by 1) parents' neural processing of gendered emotion stimuli and, and 2) children's gender-typed behavior and emotional expressions, two logistic multilevel models were run per ERP with parents' use of male or female gender labels for sad, angry, and fearful child characters as outcome variables. For the models predicting gender labeling of internalizing emotions (sadness, anxiety), the following variables were included as independent variables: 1) parents' ERP mean amplitudes toward pictures of sons and daughters paired with internalizing expression words and 2) sons' and daughters' internalizing expressions. For the models predicting stereotype-congruent and stereotype-incongruent gender labeling of externalizing emotions (anger), the following variables were included as independent variables: 1) parents' ERP mean amplitudes toward pictures of sons and daughters paired with externalizing expression words, and 2) sons' and daughters' externalizing expressions. In all models, family was included as random factor to account for the hierarchical structure of the data. As part of the assumption check, residual plots were visually examined for influential cases. An observation was deemed an outlier when its standardized residual is larger than 3 standard deviations away from the mean. When such cases were identified, analyses were repeated with and without outliers. Model residuals were visually inspected for homoscedasticity and normality.

Additionally, it was explored whether the inclusion of parent gender, task order, total duration of parents reading the picture book, and child age improved model fit, as determined by a significant decrease in the Akaike's Information Criterion (AIC) estimates (Bozdogan, 1987). Models were run with these control variables included to see whether results changed. The alpha level for the multilevel models was Bonferroni-corrected and set to $\alpha = .0028$ to account for the number of tests ($n = 18$). The sample size was a-priori determined on the basis of previous EEG studies with similar designs that included 25 – 60 participants and detected medium effect sizes (Endendijk et al., 2019; Yang et al., 2020). Power calculations were performed using G*Power 3.1 (Faul et al., 2009). A sample size of 72 participants was needed to detect a small effect size ($d = 0.2$; Cohen, 2013) in a linear regression with an alpha set to .0028. Because we accounted for relatedness in the data and since we made within-family comparisons, 74 families were included in this study.

Results

Descriptive statistics

Ten of the 148 parents were excluded from the analyses due to no or insufficient EEG trials ($n = 6$) or due to excessive noise in the data ($n = 4$). One father did not complete the observation task and was therefore excluded from all analyses. This led to 137 parents being included in the main analyses. Average scores and descriptive statistics comparing mothers and fathers can be found in Table 5.1. Correlations between the variables of interest can be found in Table 5.2.

Fathers were on average older than mothers ($t(127) = 2.53, p = .013$). Mothers and fathers were comparable in educational attainment ($p = .309$). Fathers reported spending more hours on paid work than mothers ($\chi(5) = 62.01, p < .001$). Sons ($M = 4.33, SD = 1.18$) and daughters ($M = 4.20, SD = 1.15$) were comparable in age ($p = .461$). Fathers and mothers did not differ in time to read the picture book to their children ($p = .696$). However, parents with younger sons took more time reading the picture book than when sons were older

(b = -0.96, $t(134)$ = -2.75, p = .007) but this association was not found for daughter's age (b = 0.02, $t(134)$ = 0.05, p = .963).

During picture book reading, parents were more likely to use female labels for sad child characters (M = 0.40, SD = 0.49) than to use male labels (M = 0.10, SD = 0.30; $t(136)$ = 6.11, p < .001). Parents were equally likely to use female and male labels for fearful child character (M_{female} = 0.15, SD_{female} = 0.35, M_{male} = 0.22, SD_{male} = 0.42; $t(136)$ = -1.632, p = .105) and angry child characters (M_{female} = 0.26, SD_{female} = 0.44, M_{male} = 0.34, SD_{male} = 0.48; $t(136)$ = -1.39, p = .166). With regard to the frequency of the total use of gender labels, as can be seen in Table 5.1, parents were more likely to use gender labels for the sad and angry child characters (sadness: n = 69; angry: n = 83) than for fearful child characters (n = 50).

Sons and daughters did not differ in parent-reported levels of internalizing expressions (M_{son} = 0.42, SD_{son} = 0.32, range = 0.00 – 1.33; M_{daughter} = 0.45, SD_{daughter} = 0.32, range = 0.00 – 1.00; $t(72)$ = 0.56, p = .578) and externalizing expressions (M_{son} = 0.94, SD_{son} = 0.29, range = 0.25 – 1.50; M_{daughter} = 0.87, SD_{daughter} = 0.30, range = 0.08 – 1.42; $t(72)$ = -1.58, p = .118). Mothers (M = 0.92, SD = 0.35) reported significantly higher levels of externalizing expressions for their daughters than fathers (M = 0.82, SD = 0.34; $t(72)$ = 2.47, p = .016). Parents did not differ in their reports of children's internalizing expressions (ps > .719), nor in their reports of externalizing expressions for sons (p = .053). Prevalence of internalizing behaviors and emotions was low, with 3 girls and 9 boys scoring above 1.00 on average on the internalizing behavior scale. 33 girls and 44 boys had mean scores above 1.00 on the externalizing behavior scale.

Table 5.1. Descriptive statistics describing mothers and fathers.

	Fathers (n = 70)	Mothers (n = 67)	Test statistics	p-value
Parent age, M (SD)*	37.59 (4.73)	35.79 (3.49)	$t(127) = 2.53$	.013
Time taken for PB (in minutes)	11.39 (3.77)	11.66 (4.36)	$t(130) = -0.39$	.696
Educational attainment, n (%)			$\chi^2(3) = 3.59$	.309
High school	2 (1.5%)	2 (1.5%)		
Secondary vocational education	21 (15.3%)	13 (9.5%)		
Bachelor's degree	22 (16.1%)	18 (13.1%)		
Master's degree	25 (18.2%)	35 (24.8%)		
Paid working hours, n (%)*			$\chi^2(5) = 62.01$	<.001
No paid working hours	0 (0.0%)	5 (3.7%)		
1-10 hours	0 (0.0%)	1 (0.7%)		
11-20 hours	1 (0.7%)	12 (8.8%)		
21-30 hours	3 (2.2%)	29 (21.2%)		
31-40 hours	56 (40.9%)	19 (13.9%)		
40+ hours	10 (7.3%)	1 (0.7%)		
Book version, n (%)			$\chi^2(1) = 1.66$	.198
Inside	32 (23.4%)	38 (27.7%)		
Outside	38 (27.7%)	29 (21.1%)		
Sadness labeling, n (%)				
Girl	32 (23.4%)	23 (16.8%)	$\chi^2(1) = 1.85$	.174
Boy	6 (4.4%)	8 (5.8%)	$\chi^2(1) = 0.42$	.515
Fear labeling, n (%)				
Girl	8 (5.8%)	12 (8.8%)	$\chi^2(1) = 1.15$	.283
Boy	13 (9.5%)	17 (12.4%)	$\chi^2(1) = 0.93$	.336
Angry labeling, n (%)				
Girl	17 (12.4%)	19 (13.9%)	$\chi^2(1) = 0.29$	.588
Boy	28 (20.4%)	19 (13.9%)	$\chi^2(1) = 2.06$	.151
Internalizing daughter	0.45 (0.33)	0.44 (0.32)	$t(72) = -0.36$	.719
Externalizing daughter*	0.82 (0.34)	0.92 (0.35)	$t(72) = 2.47$	.016
Internalizing son	0.43 (0.36)	0.43 (0.39)	$t(72) = 0.20$	.841
Externalizing son	0.89 (0.32)	0.99 (0.37)	$t(72) = 1.97$	.053

*$p < .05$.

Table 5.2. Correlation matrix of variables included in the multilevel model analyses (*n* = 137).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1. Label Boy Angry																					
2. Label Girl Angry	-.082																				
3. Label Boy Sad	.010	.127																			
4. Label Girl Sad	.224*	.120	.019																		
5. Label Boy Fear	.101	-.076	.171*	.142																	
6. Label Girl Fear	.050	.082	-.003	.125	.081																
7. P1 Internalizing Son	-.218*	.061	.042	-.140	.069	-.196*															
8. P1 Internalizing Daughter	-.164	.072	.172*	-.149	.055	-.257*	.716*														
9. P1 Externalizing Son	-.201*	.086	.068	-.153	.024	-.109	.758*	.746*													
10. P1 Externalizing Daughter	-.139	.079	.039	-.103	.054	-.201*	.574*	.561*	.692*												
11. P3 Internalizing Son	.110	-.055	.019	.101	-.005	.094	-.100	.099	.010	-.178*											
12 P3 Internalizing Daughter	-.043	-.059	-.063	.081	.007	.058	-.003	-.001	-.044	-.383*	.536*										
13. P3 Externalizing Son	.100	-.089	-.013	.169*	.104	.068	-.063	.008	-.013	.088	.451*	.408*									
14. P3 Externalizing Daughter	.103	-.067	.065	.111	.040	.012	-.009	-.087	.077	.273*	.061	-.015	.561*								
15. LPP Internalizing Son	-.010	.062	.068	-.062	.018	-.136	.411*	.405*	.320*	.190*	-.327*	-.172*	-.254*	-.131							
16. LPP Internalizing Daughter	-.073	.062	.088	-.033	.006	-.122	.317*	.585*	.348*	.099	-.087	-.043	-.249*	-.328*	.738*						
17. LPP Externalizing Son	-.072	.120	.074	-.044	.058	-.033	.332*	.434*	.546*	.395*	-.258*	-.314*	-.228*	.014	.714*	.696*					
18. LPP Externalizing Daughter	-.002	.085	.062	-.024	.041	-.110	.242*	.306*	.343*	.571*	-.385*	-.528*	-.155	.113	.642*	.521*	.796*				

Table 5.2. *(continued)*

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
19. Daughter Externalizing Expressions	.044	.031	-.093	.050	.082	-.046	.197*	.166	.189*	.181*	-.128	-.016	-.062	.117	.122	.070	.145	.134			
20. Son Externalizing Expressions	.129	-.059	.108	.113	.128	.141	.127	.081	.150	.091	-.034	.060	.091	.151	.121	-.002	.103	.029	.031		
21. Daughter Internalizing Expressions	.169*	-.134	-.021	.060	.150	.064	.100	.051	.029	.014	-.090	-.020	-.143	.009	.032	-.007	.006	-.026	.030	.436*	
22. Son Internalizing Expressions	.034	-.067	-.116	-.016	-.002	.002	.129	.136	.181*	.201*	-.071	-.129	-.059	-.032	.098	-.009	.123	.114	.279*	.177*	.228*

*$p < .05$.

Predictors of parental gender labeling for drawings of children displaying internalizing emotions

Table 5.3 presents the outcomes of the multilevel models with parents' use of gender labels to describe sad and fearful child characters.

Gender stereotype-congruent labeling.

For the use of the label girl in the pictures with sad or fearful child characters, none of the P1 mean amplitudes elicited by pictures of sons and daughters paired with internalizing behavior and emotion words were significant predictors (*p*s > .119). Similarly, no associations were found for P3 mean amplitudes elicited by pictures of sons and daughters paired with internalizing behavior and emotion words on parents' use of 'girl' to label the sad or fearful child character (smallest *p*-value = .132). Last, no significant associations emerged of LPP mean amplitudes elicited by pictures of sons and daughters paired with internalizing behavior and emotion words on the use of 'girl' to label the sad or fearful child character (*p*s > .525). In sum, none of parents' neural responses elicited by pairings of pictures of parents' sons and daughters with internalizing behavior and emotion words were related to whether parents labeled sad and fearful child characters in a gender stereotype-congruent manner (i.e., labeled them 'girl'). Moreover, children's mean levels of internalizing expressions were not significantly related to parents' use of gender stereotype-congruent labels (i.e., label 'girl' for sad/fearful characters) in these models (*p*s > .406).

Gender stereotype-incongruent labeling.

Parents' P1 mean amplitudes elicited by pictures of sons and daughters paired with internalizing behavior and emotion words were significantly associated with parents' use of gender stereotype-incongruent labeling of the sad child characters (i.e., 'sad boy'). Specifically, parents' P1 mean amplitudes during trials in which pictures of their son were paired with internalizing expression words were negatively related to the use of the label 'boy' with a sad child character ($b = -7.10$, $SE = 3.33$, $p = .033$). Conversely, parents' P1 mean amplitudes during pairing of pictures of their daughter with descriptions of internalizing behaviors and emotions were positively related to parents' use of the label 'boy' for the sad child character ($b = 9.46$, $SE = 3.78$, $p = .012$). However, these associations did not survive the correction for multiple comparisons. No significant associations were observed for parents' P1 mean amplitudes elicited by pictures of sons and daughters paired with internalizing behavior and emotion words and parents' use of 'boy' to label the fearful child character (*p*s > .664). In these models, children's levels of internalizing behaviors and emotions were not significantly associated with parents' use of boy to label the sad or fearful child characters (*p*s > .099).

Table 5.3. Outcomes of the multilevel models predicting the use of gender labels for sad and fearful child characters.

	Sad character						Fearful character					
	label girl (con)			label boy (incon)			label girl (con)			label boy (incon)		
P1	*b*	*SE*	*p*	*b*	*SE*	*p*	*b*	*SE*	*p*	*b*	*SE*	*p*
Mean amplitudes for daughter-internalizing	-0.09	0.11	.389	9.46*	3.78	.012	-1.52	0.97	.119	0.03	0.14	.841
Mean amplitudes for son-internalizing	-0.09	0.13	.498	-7.10*	3.33	.033	0.15	0.55	.789	0.08	0.18	.664
Internalizing expressions daughter	0.61	0.69	.379	20.11	16.51	.223	0.21	4.85	.966	1.69	1.06	.111
Internalizing expressions son	-0.06	0.59	.923	-19.27	17.90	.282	2.78	4.89	.570	-0.42	0.86	.623
P3												
Mean amplitudes for daughter-internalizing	0.03	0.11	.769	-1.03	0.63	.101	0.42	0.28	.132	0.02	0.14	.866
Mean amplitudes for son-internalizing	0.12	0.14	.379	0.82	0.63	.193	-0.58	0.47	.214	0.01	0.19	.975
Internalizing expressions daughter	0.56	0.67	.406	0.08	3.59	.982	0.58	3.06	.851	1.70	1.03	.099
Internalizing expressions son	-0.14	0.58	.804	-2.11	3.93	.590	0.14	2.67	.958	-0.31	0.84	.714
LPP												
Mean amplitudes for daughter-internalizing	0.02	0.08	.826	0.22	0.31	.465	-0.08	0.26	.754	-0.01	0.11	.989
Mean amplitudes for son-internalizing	-0.06	0.10	.525	-0.05	0.34	.878	-0.04	0.32	.895	0.02	0.13	.898
Internalizing expressions daughter	0.52	0.68	.445	0.23	2.83	.934	1.11	2.65	.674	1.69	1.02	.099
Internalizing expressions son	-0.15	0.59	.801	-1.56	2.73	.567	-0.39	2.37	.869	-0.34	0.84	.683

Note. (con) = stereotype-congruent labels, (incon) = stereotype-incongruent labels, LPP = late positive potential.
* $p < .05$

Predictors of parental gender labeling for drawings of children expressing externalizing behaviors

The detailed statistics for the multilevel models predicting parents' use of gender labels to describe the expressions of the angry child character can be found in Table 5.4.

Gender stereotype-congruent labeling

Parents' P1 mean amplitudes toward pictures of their sons and daughters paired with descriptions of externalizing expressions were not significantly related to parents' use of 'boy' to label the angry child character during picture book reading (*p*s > .059). Second, parents P3 mean amplitudes elicited by pictures of sons and daughters paired with externalizing behavior and emotion words were not significantly related to parents' use of 'boy' to label the angry child character (smallest *p*-value = .491). Last, parents' LPP mean amplitudes elicited by pictures of sons and daughters paired with externalizing behavior and emotion words did not significantly relate to parents' use of 'boy' to label the angry child character (*p*s > .126). In these models, children's levels of externalizing behaviors and emotions were also not significantly related to parents' use of 'boy' to label the angry child character (*p*s > .081). Thus, no evidence was found for a relationship between parents' neural responses elicited by pictures of sons and daughters paired with externalizing behavior and emotion words or children's externalizing behaviors and emotions in parents' use of gender stereotype-congruent labels to identify the angry child character (i.e., label boy).

Gender stereotype-incongruent labeling

No significant associations were observed for parents' P1 mean amplitudes elicited by pictures of sons and daughters paired with externalizing behavior and emotion words and parents' use of 'girl' to label angry child characters (*p*s > .513). Parents' P3 mean amplitudes elicited by pictures of sons and daughters paired with externalizing behavior and emotion words were also not significantly associated with their use of 'girl' to label the angry child character (*p*s > .423). Last, parents' LPP mean amplitudes mean amplitudes elicited by pictures of sons and daughters paired with externalizing behavior and emotion words were not significantly related to parents' use of gender stereotype-incongruent labels for the angry child character (*p*s > .227). In these models, children's levels of externalizing behaviors and emotions were not significantly related to parents' use of 'girl' to label the angry child character (*p*s > .404). In conclusion, no evidence was found for a role of parents' neural responses elicited by pictures of sons and daughters paired with externalizing behavior and emotion words or children's externalizing behaviors and emotions in parents' use of gender stereotype-incongruent labels to identify the angry child character (i.e., label girl).

Table 5.4. Outcomes of the multilevel models predicting the use of gender labels for angry child characters.

	Angry character					
	label boy (con)			label girl (incon)		
P1	*b*	*SE*	*p*	*b*	*SE*	*p*
Mean amplitudes for son-externalizing	-0.23	0.12	.059	0.05	0.12	.683
Mean amplitudes for daughter-externalizing	-0.01	0.11	.916	0.08	0.12	.513
Externalizing expressions daughter	0.63	0.73	.388	0.12	0.73	.868
Externalizing expressions son	1.43	0.82	.081	-0.63	0.78	.423
P3						
Mean amplitudes for son-externalizing	0.06	0.15	.700	-0.02	0.13	.881
Mean amplitudes for daughter-externalizing	0.13	0.18	.491	-0.13	0.18	.462
Externalizing expressions daughter	0.32	0.75	.667	0.25	0.73	.730
Externalizing expressions son	1.05	0.83	.205	-0.43	0.78	.584
LPP						
Mean amplitudes for son-externalizing	0.13	0.11	.249	-0.03	0.11	.816
Mean amplitudes for daughter-externalizing	-0.19	0.12	.126	0.16	0.13	.227
Externalizing expressions daughter	0.39	0.73	.598	0.14	0.77	.852
Externalizing expressions son	1.33	0.83	.112	-0.7	0.83	.404

Note. (con) = stereotype-congruent labels, (incon) = stereotype-incongruent labels, LPP = late positive potential.

Sensitivity analyses

Adding parent gender or child age to the previous models did not change the findings (see Supplementary Materials for more detailed information). Repeating the analyses with the mother- and father-reported levels of internalizing and externalizing behaviors and emotions separately also did not change the reported results. However, an effect of task order was observed in the use of parents' gender labeling for fearful child faces. Adding task order to the model predicting parents' use gender-congruent labels revealed that parents who started with the observation task were more likely to use the label 'girl' to identify the fearful face during picture book reading ($b = 3.39$, $SE = 1.39$, $p = .015$) in the P1 model than parents who started the test day with the EEG measurement (i.e., which might have primed them about the gendered nature of the study) but this association did not survive the multiple comparison correction. Adding task order to the model did reveal a significant main effect of parents' P1 mean amplitudes toward gender-stereotype confirmations (b = -2.16, SE = 0.67, p = .001). Parents with stronger P1 mean amplitudes to daughter-internalizing expression combinations were less likely to use gender stereotype-congruent labeling for fearful child faces (i.e., label girl).

Last, adding a variable reflecting 'time to read the picture book' showed that this covariate was significantly associated with parents' use of gender labels for sad child faces. Specifically, parents who took more time were more likely to label the sad child character 'girl' (P1: b = 0.16, SE = 0.05, p < .001; P3: b = 0.16, SE = 0.05, p = .001; LPP: b = 0.16, SE = 0.05, p < .001). This association was not found in the other models (smallest p-value = .010). No other significant associations emerged in response to adding the time variable to the models. Adding the time variable to the P1 model predicting the use of label 'boy' to indicate the sad child face led to convergence issues; however, no significant relations emerged between time taken to read the picture reading book and parents' use of the label 'boy' to describe the sad child faces in the other (P3, LPP) models (ps > .365).

Discussion

The current study examined whether parents' differential use of gender labels for children's emotions during picture book reading with their own children could be explained by a) parents' neural processing of pictures of their own son and daughter paired with words that were confirming or violating gender stereotypes about behavior and emotional expressions, or b) parents' own son's and daughter's internalizing and externalizing expressions, or c) a combination of both processes. Parents were more likely to label pictures of sad children as 'girl' than as 'boy'. However, this differentiated use of gender labels could not consistently be predicted by either parent-centered factors (i.e., neural processing) or child-centered factors (i.e., internalizing and externalizing expressions). Regarding the parent-centered factors, parents' use of 'girl' to label the fearful child character was associated with parents' P1 mean amplitudes toward pictures of their children paired with behavior and emotion words that confirmed gender-stereotyped expectations when controlling for task order. Regarding the child-centered factors, parents' reports of children's externalizing and internalizing behaviors and emotions appeared to be unrelated to parents' use of gender labels when discussing emotions of gender-neutral characters during picture book reading.

This study found limited evidence for the role of parents' neural responses to pictures of their children paired with gender-typed behavior and emotional expressions in how they used gender labels for emotional child characters during picture book reading. Importantly, most effects did not survive multiple comparison correction. However, when task order was accounted for, parents with smaller P1 mean amplitudes toward pictures of their daughters paired with internalizing expression descriptions were more likely to use the word 'girl' to label the fearful child character during picture book reading. This partly aligns with the study by Endendijk et al. (2019b), who found that parents' N2 and P3 mean amplitudes were related to mothers' evaluations of gendered behaviors during picture book reading. The P1 temporally precedes the components examined in Endendijk et al. (2019b) and this early occipitoparietal peak has been found to become smaller toward behavior gender-stereotype confirmations for people with increasing implicit gender stereotypes (Portengen et al., 2022). The current study contributes to the literature that this P1 response of parents to gender-stereotype confirmations of their own children's emotions might be related to the ways in which fathers and mothers use gender labeling of fear to teach their preschool son and daughter about gendered emotions.

In contrast to the hypotheses, this study did not find evidence for the link between parents' use of gender labels to identify gender-neutral emotional child characters and children's behavior and emotional expressions. This contradicts earlier work that revealed gender-specific links between parents' emotion socialization and children's behavioral and emotional functioning and prosocial behaviors (Chaplin et al., 2005; van der Pol et al., 2016; Zhu et al., 2023). In the current study, gender-differentiated emotion socialization was operationalized as the use of gender labels during book-reading with parents' *own* children, to identify drawings of a child character displaying various emotions, thereby measuring how parents convey gender labels (and thus gendered expectations) to their son and daughter (Friedman et al., 2007). Previous research that did find a relation between emotion socialization and child behavior and emotional expressions operationalized emotion socialization by the elaborateness of talking about emotions (van der Pol et al., 2016), the amount of attention spent toward children's emotion expression (Chaplin et al., 2005), or using surveys that measured parents' supportive or non-supportive responses toward negative affect (Zhu et al., 2023). The differences in measurements of emotion socialization may explain the differences in findings between studies.

Importantly, the current study adopted a within-family comparison framework to examine the differential treatment of sons and daughters by mothers and fathers in the same family. Surprisingly, little evidence was found for parents' differential use of gender labels to identify gender-neutral child characters with various emotions or for gender differences in son's and daughter's behavioral and emotional functioning within families. The lack of gender differences in this study might indicate that parents with both a son and a daughter are less inclined to employ gender-differentiated emotion socialization. This largely aligns with previous research that found that the presence of children of both genders in a family leads to less gender stereotypes and gendered communication by parents (Endendijk et al., 2013; Endendijk et al., 2014) and less gender-typed behavior in children (Kuchirko et al., 2021). Previous studies examining gender-differentiated socialization strategies have often compared the socialization of parents of sons with parents of daughters (Endendijk et al., 2019a; Endendijk et al., 2019b; Mascaro et al., 2017; van der Pol et al., 2015). The lack of findings regarding the differential use of gender labels is in contrast with work by McHale and colleagues who demonstrated that parents with sons and daughters were *more* likely to apply gender-differentiated parenting than parents with same-gender children (McHale et al., 1999; McHale et al., 2000). However, the studies by McHale and colleagues have mainly investigated gendered behavior during middle childhood and focused on parents' differential treatment of sons and daughters as opposed to gendered communication toward both children. Examining these processes within a family, by comparing parenting of preschool-aged sons with parenting of daughters, thus provides unique insights into the application of gender-differentiated emotion socialization strategies within a household in which both genders are raised.

It is important to note that parents' use of gender labels was relatively infrequent (10.2 - 40.2% of the sample). This implies that more than half of the parents did not use any gender label to describe the child character in the picture books. The use of gender labels in itself has also been found to be a source of gender socialization for children, emphasizing the importance of gender and highlighting the appropriateness of certain behaviors and emotions for boys and girls (Friedman et al., 2007). It appears that the parents included in this study might thus be less likely to convey gendered messages about emotions to their sons and daughters. Perhaps the drawings of the child characters used in the current study were not evocative enough for parents to discuss in terms of gender with their children, especially in families with both a son and daughter. Although the gendered focus of the current study was not made explicit, parents often indicated their awareness of the gendered nature of the study to the researchers when they were performing the tasks. Participating families may thus have been more likely to act in a socially desirable manner during the picture book reading observation task.

Another explanation might be that the parents participating in this kind of research already have an attitude that downplays gender differences or gender particularities, in line with the gender egalitarian attitudes that are visible in the Dutch culture. However, similar studies that found evidence of parental gender socialization among preschool children were also performed in the Netherlands and thus in similar cultural contexts (e.g., Endendijk et al., 2014; van der Pol et al., 2016; van der Pol et al., 2015). Differences between this study and the previous Dutch studies might be related to power issues as our sample size is much smaller than the before-mentioned studies. Moreover, in the study by Endendijk et al. (2014), differences in the use of gender labels were only found for gender-neutral child characters performing masculine activities, but not feminine activities, specifically among fathers with two sons (as opposed to two daughters or mixed-gender siblings). In this study, the opposite was found, with parents being more likely to use the label 'girl' to identify a sad child character but no differences in parents' likelihood to use 'boy' or 'girl' to label angry child characters.

Last, in this study, mothers and father did not differ in the frequency in which they used gender labels to identify emotional child characters. This confirms a previous study that compared the use of gender labels between mothers and fathers which found no differences (van der Pol et al., 2015). Our finding contradicts studies that explored other types of gender socialization or emotion talk (Lytton & Romney, 1991). For example, mothers are more likely to talk about and elaborate on emotions with their children than fathers (Fivush et al., 2000; van der Pol et al., 2015). Moreover, fathers have been found to be more likely to confirm gender stereotypes about toy and activity preference during picture book reading (Endendijk et al., 2014), and to be less likely to explain science to daughters than sons (Crowley et al., 2001).

Limitations and future research directions

This study entailed a complex data collection combining neuroscience with real-life observational data and employing a within-family design. An important limitation may have evolved from the design of the study, in which half of the parents started with the EEG measurement; task order appeared to modulate the relation between P1 mean amplitudes and parents' use of gender labels for the fearful child character. The EEG task clearly revealed the gendered nature of this study and may therefore have motivated parents to use less gender labels during picture book reading than when the gendered nature of this study was more subtle (i.e., when parents started with the observation task). We therefore recommend future studies examining the implicit nature of parental gender socialization to minimize priming parents with gendered nature of the study before obtaining gender socialization measurements.

Second, the BPC that was used as a parent-report measure of internalizing and externalizing behaviors and emotions was originally developed for children aged 7 years and older (Chorpita et al., 2010). Despite its reliable use as a parent-report measure in younger populations (Brassell et al., 2016; Sanders et al., 2016), in the current study the reliability coefficients were somewhat smaller, and barely acceptable. Moreover, mothers and fathers did not agree in their reports of their daughter's externalizing expressions; with mothers reporting higher scores than fathers. This might reflect gender differences in parental involvement in childcare. In the current sample, fathers spent more hours on paid work than mothers. The increased time that mothers spend in the home environment might have increased their opportunities to observe these behaviors and emotions in their children. It is not uncommon for parents to report different levels of internalizing and externalizing behaviors for preschool children (e.g., Duhig et al., 2000; Grietens et al., 2004; Treutler & Epkins, 2003), and previous research has found this to be partly explained by elements of parent-child relationships such as time spent with children and parental acceptance (Treutler & Epkins, 2003). Importantly, children's levels of problematic behavior and emotional expressions in this study were low, which may have limited the probability of finding significant relations between children's behavioral and emotional functioning and gender-differentiated emotion socialization.

Third, as previously discussed, the way that gender-differentiated emotion socialization was measured might not have been a robust enough manipulation to elicit gender labeling among parents. In addition, this study only coded parents' responses to the pictures of emotional child characters during picture book reading and not their own children's use of gender labels or gender-stereotyped responses. It would be interesting to examine whether parents and children use the same gender labels and whether sons and daughters respond differently toward the different emotion expressions. Moreover, including children's responses toward the child character could provide a more complete picture of the parent-child conversations about gender and emotions during picture book reading.

Fourth, there was considerable variation in the time parents took to discuss the picture book with their children. Some parents were finished within 5 minutes, whereas others took 18 minutes. The likelihood of using labels or making gender-related comments is smaller when parents rushed through the picture book. We did not set a minimal time limit because we wanted to observe parents' picture book reading in a naturalistic setting, in this case, in the home context and without setting a minimum time. However, since this may have impacted the likelihood of using labels during picture book reading, we would recommend future research to set more specific time boundaries for these types of observational tasks. Similarly, the parents were recruited via convenience sampling and the sample consisted of predominantly White, highly-educated, mixed-gender parent dyads, which limits the generalizability of our findings. Since gender is known to interact with other individual characteristics such as age, race, and social status (Al-Faham et al., 2019), it is important to replicate this study among a more diverse sample of parents.

Last, the current study examined parents' brain responses toward pictures of their own son and daughter that were paired with words that represented internalizing and externalizing behaviors. Future research could investigate whether the specific neural responses toward fear, sadness, or anger would provide unique relations with parents' use of gender labels for child characters displaying corresponding emotions. Similarly, future research could examine whether parents' neural responses toward gender stereotypes are related to other types of gender-differentiated emotion socialization, such as elaborateness of emotion talk (Fivush et al., 2000; Fivush & Buckner, 2000) or parents' observed responses to their children's emotion expression (Chaplin et al., 2005).

Conclusion

This study found some evidence in families with mixed-gender siblings for the relationship between parents' early occipitoparietal processing of gender stereotypical stimuli of their own sons and daughters and parents' use of gender labels to describe gender-neutral child characters expressing various emotions. Moreover, parent-reports of their children's levels of behavior and emotional expressions appeared to be unrelated to the parents' use of gender labeling during picture book reading. These findings could indicate that in families with mixed-gender sibling constellations, gender socialization is less pronounced. This study, however, found more evidence for the role of parents' neural responses elicited by their own children's gender-stereotyped behavioral and emotional functioning in gendered emotion socialization than gender differences in children's actual behavioral and emotional functioning. With regard to research in the domain of gender socialization, it appears to be important to take into account task order when designing a combined EEG-observation study. The findings of this study warrant future research to disentangle the within-family and between-family variation in gender-differentiated socialization strategies adopted by parents and the role of neural processing of gendered information.

6

Women are expected to smile: Preliminary evidence for the role of gender in the neurophysiological processing of adult emotional faces in 3-year-old children

Christel M. Portengen[1], Caroline M. M. Junge[2], Anneloes L. van Baar[1], Joyce J. Endendijk[1]

[1] Child and Adolescent Studies, Clinical Child and Family Studies, Utrecht University, Utrecht, The Netherlands

[2] Experimental Psychology, Utrecht University, Utrecht, The Netherlands.

This chapter is accepted for publication as: Portengen, C. M., Junge, C., van Baar, A. L., & Endendijk, J. J. (2023). Women are expected to smile: The role of gender in the neurophysiological processing of adult emotional faces in 3-year-old children. *Developmental Psychobiology.* https://doi.org/10.1002/dev.22443

Abstract

Children form stereotyped expectations about the appropriateness of certain emotions for men versus women during the preschool years, based on cues from their social environments. Although ample research has examined the development of gender stereotypes in children, little is known about the neural responses that underlie the processing of gender-stereotyped emotions in children. Therefore, the current study examined whether 3-year-olds differ in the neural processing of emotional stimuli that violate gender stereotypes (i.e., male faces with fearful or happy expressions) or confirm gender stereotypes (i.e., female faces with fearful or happy expressions), and whether boys and girls differ in their neural processing of the violation and confirmation of gender stereotypes. Data from 72 3-year-olds (± 6 months, 43% boy) were obtained from the YOUth Cohort Study. Electroencephalography data were obtained when children passively viewed male and female faces displaying neutral, happy, or fearful facial expressions. This study provided first indications that happy male faces elicited larger P1 amplitudes than happy female faces in preschool children, which might reflect increased attentional processing of stimuli that violate gender stereotypes. Moreover, there was preliminary evidence that girls had larger Nc responses, associated with salience processing, toward female happy faces than male happy faces, whereas boys had larger negative central (Nc) responses toward male happy faces than female happy faces. No gender differences were found in the processing of neutral and fearful facial expressions. Our results indicate that electroencephalography measurements can provide insights into preschoolers' gender-stereotype knowledge about emotions, potentially by looking at the early occipital and late fronto-central responses.

Introduction

There is a generally held belief that men and women differ in their emotion expression, with women being the more emotional gender, despite inconsistent evidence to confirm this statement (Barrett et al., 1998; Fischer, 1993; Robinson et al., 1998; Simon & Nath, 2004). Moreover, women are believed to experience and express emotions such as fear, sadness, and happiness more often than men, whereas men are believed to experience and express anger and pride more often than women (Plant et al., 2000). This gender stereotyping of emotions already starts during preschool years (Birnbaum & Chemelski, 1984). Although ample research has focused on the gender stereotyping of emotions in adults (for an overview, see Brody & Hall, 2008), little is known about young children's gender-stereotyped expectations about individual emotions. Moreover, it is difficult to measure gender stereotypes in young children, especially during the preverbal stage (Poulin-Dubois et al., 2002). Neuroscientific measures, and specifically electroencephalography, might be useful in this regard as they can provide temporal information about the neural processing of gender-stereotyped stimuli from children's environment. Therefore, the current study examined children's brain responses toward male and female emotional faces that violate versus confirm gender stereotypes.

Gender stereotypes in preschool children

Gender stereotypes are a socially shared set of expectations about the characteristics, behaviors, and roles of men and women (Greenwald et al., 2002). According to the gender schema theory, gender stereotypes can be seen as a type of gender schema (Bem, 1981, 1983; Martin & Halverson, 1981). Gender schemas are dynamic cognitive frameworks through which information is filtered and categorized, affecting the perception and processing of gender information in one's environment (Bem, 1981, 1983; Martin & Halverson, 1981). Children play an active role in the development of their gender schemas, for instance by selectively attending to and searching for gender cues in the environment and actively incorporating the information in their gender schemas (Bem, 1981, 1983; Martin & Halverson, 1981).

Several studies provide evidence that children's gender schemas indeed alter the processing of gendered information in the environment. These studies have often applied preferential looking paradigms to measure gender stereotypes in (preverbal) children. Findings showed that toddlers looked longer at stimuli that violated gender stereotypes, such as a woman putting on a tie, compared to stimuli that confirmed stereotypes, such as a woman putting on make-up (Hill & Flom, 2007; Poulin-Dubois et al., 2002; Serbin et al., 2001; Serbin et al., 2002). Toddlers were also found to look longer at stimuli that violated metaphorical gender stereotypes, such as a heart combined with a male face, or a bear combined with a female face (Eichstedt et al., 2002). At the age of 3, both boys and girls appeared to have acquired knowledge of gender stereotypes (Gonzalez et al., 2022; Weinraub et al., 1984) and had better memory for gender-stereotyped objects that fit the stereotypes for their own gender (e.g., train for a boy), than gender-stereotyped objects that violated their own gender stereotypes (e.g., a Barbie for a boy) (Cherney & Ryalls, 1999).

Not only do children develop gender stereotypes about objects and activities, but gender stereotypes are particularly prevalent in the domain of emotions. Infants have been found to distinguish emotion expressions based on gender. For instance, 3.5-month-old infants looked longer at female smiling expressions compared to male smiling expressions (Bayet et al., 2015b). In a different set of cross-sectional experiments, Bayet et al. (2015a) found that during childhood, children are more likely to categorize angry faces as male than female and this effect is robust across multiple ages and in adulthood. Together, these two studies have been interpreted as children associating negative emotions more with men, but positive emotions more with women (Quinn et al., 2019). The next step is to examine whether these gender stereotypes about emotions are also visible at a neural level.

The gender of the child needs to be taken into account in itself when examining neural processes underlying children's responses to gender stereotypical information. Some evidence shows that girls appear to acquire several types of gender schemas at an earlier age than boys (Poulin-Dubois et al., 2002; Zosuls et al., 2009). For example, girls use gender labels at an earlier age than boys (Zosuls et al., 2009) and can more consistently assign gender-stereotyped activities to the corresponding gender around the age of 2 (Poulin-Dubois et al., 2002). A meta-analysis revealed that during preschool years, girls also make more gender-stereotyped matches than boys when forced to select boys or girls, although differences were small and the reverse was found when children were given the option to choose both (Signorella et al., 1993). Moreover, girls show an advantage over boys in decoding others' emotions, especially during infancy and early childhood (McClure, 2000). Thus, it seems likely that girls might also respond more strongly than boys to the violation of gender stereotypes about emotional faces on a neural level.

Brain's processing of gendered emotional stimuli

To measure children's brain responses, researchers have often relied on electro-encephalography (EEG) measurements to measure event-related potentials (ERPs). ERPs are time-locked epochs of neural activation patterns that occur after the presentation of a stimulus. Several relevant ERPs, associated with attention allocation, information processing, and salience processing, have been identified in research on children's brain responses toward emotional faces and adult responses toward gender stereotypes.

For children, the following ERPs are relevant in the context of the neural processing of neutral, happy, angry, and fearful faces: P1, P2, N290, P400, and Negative central (Nc). The P1 and P2 reflect early visual processing of stimuli, and peak earlier for fearful faces when compared to happy faces in P1 (Batty & Taylor, 2006) and compared to neutral faces in the P2 (Dawson et al., 2004). Both N290 and P400 are precursors for the adult N170, a face-specific occipital-temporal component reflecting the rapid structural processing, encoding, and attention to faces (Bentin et al., 1996; de Haan et al., 2003; de Haan et al., 1998). In young children, N170 peaks appeared faster when a child was shown a fearful facial expression compared to an angry or happy facial expression (de Haan et al., 1998). The Nc component is thought to reflect increased attention to salient stimuli (de Haan et al., 2003; Hajcak et al., 2013). As such, fearful facial expressions have elicited larger Nc amplitudes than neutral facial expressions (Batty & Taylor, 2006; Dawson et al., 2004). However, none of these studies examined whether the gender of the person displayed elicited differences in children's neural processing of emotional faces. That is, we do not yet know how children's sensitivity to gender stereotype-violating or gender stereotype-confirming emotional stimuli is reflected in strengths of these ERPs. Information about which ERP could be relevant for the neural processing of gender-stereotyped emotional faces can be derived from adult studies examining the neural processing of expectancy violations.

In adults, similar components have been identified in stereotype research. For example, when presented with a female angry face, adults were slower to judge the gender of the face and had elevated P1 peaks than when viewing a female happy face (Liu et al., 2017). In the same study, male happy faces elicited a more negative N170 wave than female happy faces. Moreover, male angry facial expressions (gender stereotype-confirming) elicited larger late positive potential (LPP) peaks and took less time to be identified as angry than male happy faces (gender stereotype-violating) (Liu et al., 2017). The LPP is most often associated with salience processing in adults (Brown et al., 2012). More generally, the LPP was found to be larger during stereotype-violating trials in prime-target combinations (e.g., 'anger' and a fearful facial expression) than stereotype-confirming trials (Krombholz et al., 2007; Werheid et al., 2005). Other components, such as the P2, N2, P3, and N400, have been found to elicit larger mean amplitudes during stereotype-violating trials in comparison to stereotypes that were confirmed in social expectancy violation and stereotype research in adults (Dickter & Gyurovski, 2012; Healy et al., 2015; Jerónimo et al., 2017; Proverbio et al., 2018; Yang et al., 2020). In sum, the P1, N170, P2, N2, P3, and N400 have all been found to be larger for stereotype-violating than stereotype-confirming stimuli, whereas the LPP has been found to be larger for stereotype-violating stimuli in some studies and larger for stereotype-confirming stimuli in other studies.

Current study

To summarize, behavioral evidence shows that children and adults respond differently to instances of gender-stereotype violations versus gender-stereotype confirmations. We do not yet know the neural correlates of such differentiation in children's brains. Furthermore, it is unclear whether child gender plays a role in this differentiation. Therefore, the current study examined whether 3-year-old children differ in the neural processing of emotional stimuli that either violate gender stereotypes (i.e., male faces with fearful or happy expressions) or confirm gender stereotypes (i.e., female faces with fearful or happy expressions). In addition, differences between boys and girls in the neural processing of the violation and confirmation of gender stereotypes are studied. Based on previous studies and the gender schema theory, expectations were that (1) 3-year-old children respond differently to gender-stereotype violating emotion stimuli (i.e., male faces with fearful or happy expressions) and gender-stereotype confirming emotion stimuli (i.e., female faces with fearful or happy expressions), as evidenced in ERPs in children that frequently were implicated in research in both gender stereotypes and processing of emotional faces (P1, P2, N290, P400, and Nc); (2) a difference in the processing of male and female faces is not expected in a neutral face condition; and (3) girls respond more strongly on a neural level to the violation of gender stereotypes in emotion expression than boys. Table 6.1 contains an overview of the expected direction of effects per ERP and per face condition. However, how the specific directionality of effects unfolds in children's neural processing is explorative in nature. Finally, because children's age range was rather broad (3-year-olds ± 6 months), we explored the role of children's age in the neural processing of gender stereotype-violating and gender stereotype-confirming emotional stimuli. A child's age in toddlerhood impacts the latency and amplitude of ERPs linked to emotional expressions (Batty & Taylor, 2006) and a child's gender-stereotype knowledge and endorsement (Serbin et al., 2001; Serbin et al., 2002; Weinraub et al., 1984).

Table 6.1. Expected direction of effects in ERP mean amplitude and latencies regarding gender-stereotype violations.

ERP		Happy faces	Fearful faces	Neutral faces
P1	mean amplitude	Male > Female	Male > Female	Male = Female
	latency	Male > Female	Male > Female	Male = Female
P2	mean amplitude	Male > Female	Male > Female	Male = Female
	latency	Male > Female	Male > Female	Male = Female
N290	mean amplitude	Male > Female	Male > Female	Male = Female
	latency	Female > Male	Female > Male	Male = Female
P400	mean amplitude	Male > Female	Male > Female	Male = Female
Nc	mean amplitude	Male > Female	Male > Female	Male = Female

Note. Nc = Negative central

Methods

Participants

Data were obtained from the YOUth Cohort study (https://www.uu.nl/en/research/youth-cohort-study), a Dutch population-based longitudinal cohort study that examines the interplay of psychological, environmental, and biological processes in the development of social competence and self-regulation of children in different age ranges (for more information about the design and procedures, see Onland-Moret et al., 2020). Two cohorts are included in the YOUth study; the YOUth Baby & Child cohort which follows infants from 20-week gestational age until the age of 6 years and the YOUth Child & Adolescent cohort which follows children aged 8 until 16 years. In the current study we used data from the YOUth Baby & Child cohort. Exclusion criteria for the YOUth Baby & Child cohort were mental or physical restrictions that prevented the child from completing the tests during lab visits, or parents having insufficient understanding of the Dutch language to understand the instructions and fill out the questionnaires. For the current study, 127 children (43% boys) between the ages 2.5 – 3.5 years (M = 35.35, SD = 3.99, in months) were included who had participated in the EEG data collection during the 'around-3-years wave' of the Baby & Child cohort.

Procedure

A detailed description of the procedures in the cohort has been published elsewhere (Onland-Moret et al., 2020). In short, parents have provided written informed consent for themselves and their child to participate in the study prior to each measurement wave in which they were invited for a lab visit. During the lab visit, parent and child were seated in a dimly lit, soundproof room while the child was wearing an EEG cap. Each testing room was controlled for luminance (between 8-20 lux, usually around 12 ± 2). Continuous EEG data were collected while children were completing the Face House Task and the Face Emotion Task (see Measures). Parents were instructed to stay with their child during the EEG assessment but not to interact with their child during the experiment. A video camera was placed below the screen to record the child's looking behavior.

Measures

Face House Task

Children passively watched colored pictures of six female faces (identities: 12, 22, 26, 27, 37, and 61) and six male faces (identities: 7, 15, 25, 36, 49, and 71) with a neutral facial expression from the Radboud Faces database (Langner et al., 2010) and 12 colored pictures of houses for 1000ms, with a jittered interstimulus interval (ISI) between 700 and 1000ms. Male and female faces were selected based on the highest percentage of agreement (ranging from 83% to 100%) on emotion categorization as reported by Langner et al. (2010). The faces displayed no facial hair, nor fringes, make up, or jewelry (Langner et al., 2010). In addition, the faces were displayed with hair pulled back so that ears were visible. The full set of stimuli is reported in the Supplementary Materials in Figure S1 and Di Lorenzo et al. (2020). The stimuli (20.5 cm width x 22.5 cm height, visual angle: 19.4° x 21.2°) were superimposed on a gray background (RGB: 108). Mean luminance in the neutral face ranged from 107.53 to 114.64, with no differences between male faces and female faces. During the ISI, children saw a red, yellow, green, or blue square in the middle of the screen (5.3cm x 5.3cm, visual angle: 4.7° x 4.7°). The task consisted of 96 trials (4 x 12 houses, 4 x 12 neutral faces) divided into four blocks. Per block of 24 trials, all pictures appeared once in a randomized order. To maintain the child's interest, the child was asked to press a button whenever they saw a ball appearing. This was programmed after every 24 pictures (four times per task); after they pressed, an attention starter (short animation clip) started for 2 seconds. Between blocks and whenever the child was not looking at the screen, the experimenter played additional sound or video clips as attention grabbers. The task lasted 3-4 minutes. For the current study, only the trials in which a face with a neutral expression was presented were included in data analysis.

Face Emotion Task

After completing the Face House Task, children were presented with the same six female and six male faces from the Radboud Faces database (Langner et al., 2010) as during the Face House Task, but now showing those with a happy facial expression and with a fearful facial expression. Again, the stimuli (20.5 cm width x 22.5 cm height, visual angle: 19.4° x 21.2°) were depicted on a gray background (RGB: 108) and the same four colored squares were presented during ISI. Mean luminance ranged between 106.99 to 114.54 for happy faces and 107.20 to 113.73 for fearful faces. Again, male faces did not differ from female faces in mean luminance. Stimuli were presented for 1000ms, after which a jittered ISI followed between 700 and 1000ms. The task consisted of 96 trials (4 x 12 happy faces and 4 x 12 fearful faces) divided into four blocks. Each block consisted of 24 trials, in which all pictures appeared once in a randomized order. Children were again asked to press a button whenever they saw a ball appearing, which was programmed after every 24 pictures. Again, when a child was looking away from the screen or in between blocks, sound and video clips were presented as attention grabbers. This task took 3-4 minutes to complete.

EEG recordings

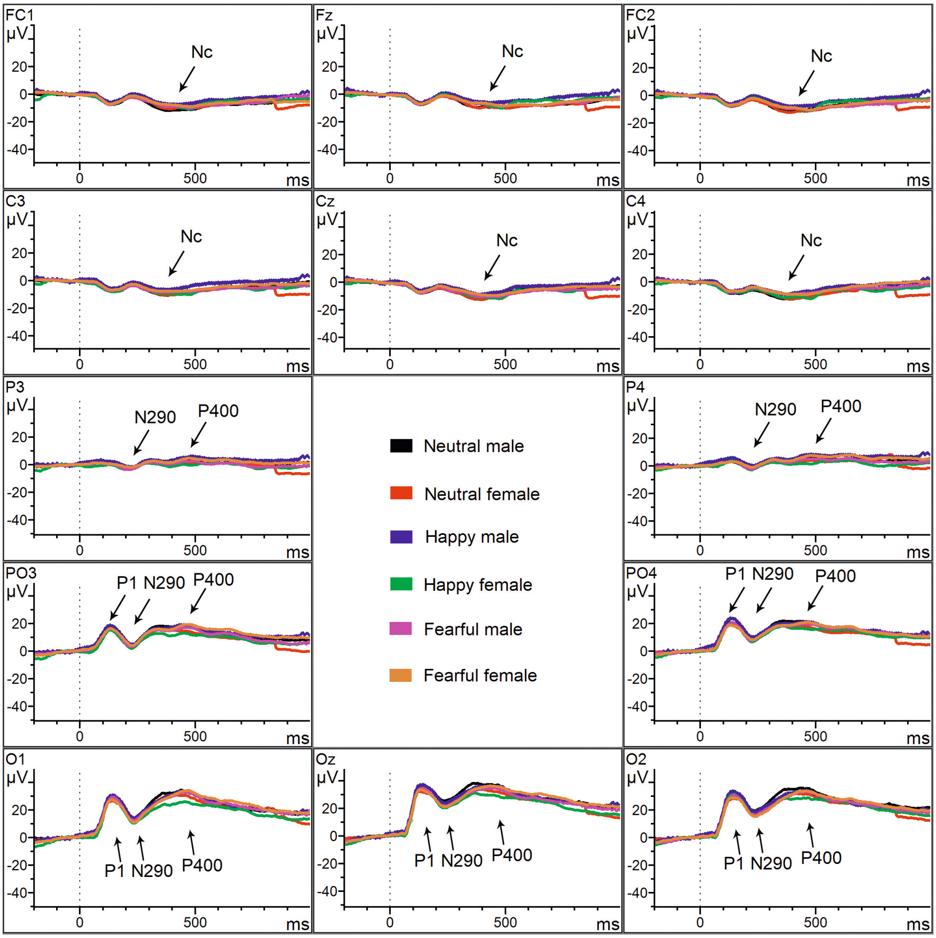
During each task, continuous EEG data were recorded using the 32-channel BioSemi ActiveTwo hardware (BioSemi, 2011). The electrodes were placed according to the 10-20 electrode system with use of a nylon electrode cap (Klem et al., 1999). EEG signals were sampled at 2048 Hz using Actiview (version 7.05). For more details see Di Lorenzo et al. (2020).

Data was offline processed using Brainvision Analyzer using the same criteria and pre-processing steps as a previous study that analyzed ERP data from earlier waves of the same cohort (Di Lorenzo et al., 2020). This entailed that data was downsampled to a 512 Hz sampling rate, after which the data were bandpass filtered between 0.1 and 30 Hz and a notch filter of 50 Hz. Data were then segmented into epochs of -200ms to 1000ms, time-locked to the onset of stimuli. Subsequently, a baseline correction was applied from -100 to 0 to correct for differences in absolute voltage and drift between trials and electrodes. Artifacts were rejected semi-automatically. Trials were marked as bad and manually inspected if the voltage step exceeded 50 uV/ms, with a maximum allowed difference of values in intervals of 200 uV within a 200ms window, or with a lower activity in intervals of 3 uV. An electrode was rejected if there were less than 5 artifact-free trials and if the electrode was not one of the electrodes of interest (Oz, O1, O2, PO3, PO4, P3, P4, Fz, Cz, FC1, FC2, C3, C4). An entire trial was discarded if artifacts were visible across more than 16% of the electrodes or in the electrodes of interest. Additionally, trials were manually removed if the child looked away from the screen or had his/her eyes closed between 0 and 800ms after stimulus onset, as determined by visual inspection of video tapes of children's looking behaviors. Finally, a reference activity was created from the mean of all electrodes per child, to which the child's data was then re-referenced. Data for each individual participant were then segmented and averaged into six grand average waveforms per condition (neutral female face, neutral male face, happy female face, happy male face, fearful female face, fearful male face). A child was excluded from further analyses when there were less than 10 valid trials in one of the segments. Finally, total average waveforms per condition were created from the grand average waveforms per participant. Figure S2 – S4 depict the total grand average waveforms during the neutral, happy, and fearful face condition, respectively.

Event-related potentials

Time windows and electrodes for the ERP components of interest were selected based on previous research and by visually examining the total grand average waveforms (see Figure S5 for grand average waveforms for all conditions). For the P1, occipital-parietal electrodes were selected (O1, O2, Oz, PO3, and PO4) with a time window of 90-190ms (Di Lorenzo et al., 2020; Luyster et al., 2014). For the N290 and P400, occipital-parietal electrodes were selected (P3, P4, O1, O2, Oz, PO3, and PO4) with a time window of 170-300ms (Di Lorenzo et al., 2020) and 325-600ms (Munsters et al., 2019), respectively. For the Nc, fronto-central electrodes were selected (Fz, Cz, C3, C4, FC1, and FC2) with a time window of 300-600ms (Di Lorenzo et al., 2020; Munsters et al., 2019). Although additional electrodes may have been of interest (e.g., P7, P8, F3, and F4) in view of other research (e.g., Kuefner et al., 2010), these were not included in this study due to low data quality and to adhere to similar analyses carried out with the YOUth data set (di Lorenzo et al., 2020). Figure 6.1 depicts the grand average waveforms for all conditions in the electrodes of interest. No clear P2 component could be identified in the grand average waveforms and was therefore not further analyzed. For all components, mean amplitudes were derived. Additionally, for the early components (P1 and N290), peak latency was calculated as the time point at which a maximum positive or negative peak occurred within the selected time windows, separately for each electrode. This was not done for later components because no clear peaks were detectable in the later, mid-latency P400 and Nc components (see also Di Lorenzo et al., 2020).

Figure 6.1. Grand average waveforms during the neutral, happy, and fearful face conditions, separate for male and female faces, in the electrodes of interest.



Note Time in milliseconds is on X-axis (with 0 representing onset of visual stimulus) and amplitude is on the Y-axis (positive polarity plotted upwards). All electrodes are arranged according to layout: from left to right, and from frontal to posterior.

Data analyses

Mean amplitudes for all ERPs and peak latencies for P1 and N290 were exported from Brainvision Analyzer and imported into R (version 4.1.0) for further data analyses. Separate multilevel models were run to examine differences in neural responses toward male and female faces for each emotion (neutral, happy, fearful) and for each ERP (P1, N290, P400, and Nc) with the use of the lme4 package (Bates et al., 2018). As recommended by Volpert-Esmond et al. (2021), participant identifier and channel were included as random intercepts, and stimulus gender (male and female) as random slope per participant. Mean amplitudes and peak latencies were included as dependent variables in the model. Stimulus gender, participant gender, and age in months were included as independent variables, together with an interaction term between stimulus gender and participant gender. This led to the following model tested in R:

EEG ~ Stimulus.Gender + Gender + Stimulus.Gender x Gender + Age
+ (Stimulus.Gender|Participant) + (1|Channel)

The Satterthwaithe's method was used to estimate the degrees of freedom and *p*-values for the fixed effects.

Results

Pre-processing

During EEG preprocessing, a total of 55 children were excluded for several reasons. First, 36 were excluded because of insufficient valid trials (< 10) in one or multiple conditions. Another nine children were excluded because of severe artifacts in most of the trials on multiple electrodes. Missing or incomplete EEG recordings led to the exclusion of 10 children. This resulted in a sample of 72 children who were included in the data analyses. No differences were found between the included and excluded group regarding the children's age, gender, parents' ethnicity, or parents' family composition (see Table S1 for the group comparison statistics). Residual plots were visually examined for influential cases. An observation was deemed an outlier when its standardized residual was larger than three standard deviations away from the mean ERP amplitude, averaged over the electrodes. When such cases were identified, analyses were repeated with and without outliers. Model residuals were visually inspected for homoscedasticity and normality; these assumptions were violated for the models containing outliers. Excluding the influential cases led to all assumptions being met.

Descriptive Statistics

Table 6.2 contains the sample characteristics, separate for boys and girls. All children for which data on date of birth and due date were available (n = 60) were born at-term (37 - 42 weeks, n = 56) or moderately-to-late preterm (35 - 37 weeks, n = 4). Boys and girls did not differ in age, ethnic background, or family compositions of fathers and/or mothers.

Table 6.2 Descriptive characteristics of boys and girls.

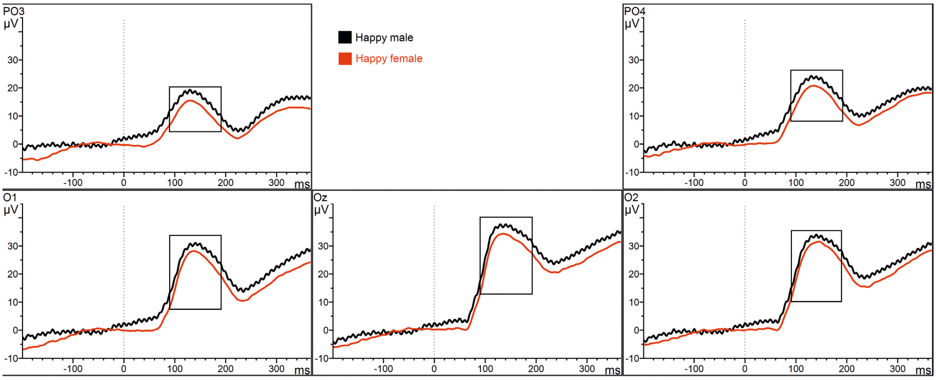
Characteristic	Boys (*n*=33)	Girls (*n*=39)	test statistics (df)	p
Age in months, *M (SD)*	35.67 (3.85)	35.38 (4.23)	$F(1, 70) = 0.09$	.770
Ethnicity mother, *n* (%)			$\chi^2(1) = 0.01$	.935
Dutch	29 (44.6%)	33 (50.8%)		
Other Western country	2 (3.1%)	1 (1.5%)		
Ethnicity father, *n* (%)			$\chi^2(2) = 2.01$	.367
Dutch	28 (46.7%)	30 (51.7%)		
Other non-Western country	1 (1.7%)	0 (0%)		
Other Western country	0 (0%)	1 (1.7%)		
Family composition (mother), *n* (%)			$\chi^2(1) = 1.80$	.179
Living with child(ren)	0 (0%)	2 (3.4%)		
Living with partner & child(ren)	27 (46.6%)	29 (50.0%)		
Family composition (father), *n* (%)			$\chi^2(2) = 1.02$	.600
Living with partner only	1 (1.9%)	1 (1.9%)		
Living with child(ren)	0 (0%)	1 (1.9%)		
Living with partner & child(ren)	25 (48.1%)	24 (46.2%)		

P1

Table 6.3 contains an overview of the test statistics of the mean amplitude and peak latency analyses of the P1 component for the emotion conditions. No main effect of stimulus gender on P1 amplitudes was found in any of the emotion conditions (neutral: $p = .603$; happy: $p = .442$; fearful: $p = .710$). Additionally, there were no significant interactions between stimulus gender and child gender in the neutral, happy, or fearful faces conditions (neutral: $p = .166$; happy: $p = .824$; fearful: $p = .322$). With regard to peak latency, age was negatively associated with P1 peak latency in all conditions regardless of child or stimulus gender (neutral: $\beta = -.198$, $t(72) = -2.61$, $p = .011$; happy: $\beta = -.198$, $t(72) = -2.70$, $p = .009$; fearful: $\beta = -.240$, $t(72) = -3.24$, $p = .002$).

Checking model residuals revealed one outlier for the happy face mean amplitude analysis and one outlier for the fearful face mean amplitude analysis. Excluding this outlier led to a significant main effect for stimulus gender in P1 mean amplitude voltage during the happy face condition ($\beta = -.116$, $t(71) = -2.08$, $p = .041$). Male happy faces elicited a larger P1 mean amplitude than female happy faces (see Figure 6.2). The interaction between child gender and stimulus gender remained non-significant (β = .116, $t(71)$ = 1.72, p = .089). Excluding the outlier in the fearful face condition did not change the significance of the results (smallest p = .237 for the interaction between child gender and stimulus gender).

Figure 6.2. ERP waveforms during the happy face condition in which P1 amplitudes were larger toward happy male faces than happy female faces.



Note. The marked selection indicates the selected P1 time window (90 – 190 ms).

Table 6.3. Test statistics of the uncorrected P1 mean amplitudes and peak latency with variables of interest.

Condition	Variable	P1 mean amplitudes (uV)			P1 peak latencies (ms)		
		β	t(df)	p	β	t(df)	p
Neutral	stimulus gender	-.025	-0.52 (70)	.603	.098	1.69 (72)	.095
	child gender	.041	0.46 (69)	.648	-.048	-0.59 (72)	.559
	age	.024	0.31 (69)	.761	-.198*	-2.61 (72)	.011
	stimulus gender*child gender	-.084	-1.40 (70)	.166	-.035	-0.50 (72)	.622
Happy	stimulus gender	-.088	-0.77 (72)	.442	-.065	-1.25 (72)	.214
	child gender	.108	0.93 (72)	.355	-.088	-1.02 (72)	.312
	age	.041	0.82 (71)	.415	-.198*	-2.70 (72)	.009
	stimulus gender*child gender	-.031	-0.22 (72)	.824	.073	1.16 (72)	.249
Fearful	stimulus gender	.026	0.37 (72)	.710	.042	0.64 (72)	.522
	child gender	.043	0.48 (71)	.633	-.113	-1.33 (72)	.189
	age	-.022	-0.30 (71)	.761	-.240*	-3.24 (72)	.002
	stimulus gender*child gender	-.084	-1.00 (72)	.322	.035	0.44 (72)	.660

Note: For stimulus gender, male was coded as reference category. For child gender, boy functioned as reference category. * $p < .05$

N290

Table 6.4 contains an overview of the test statistics regarding the mean amplitude and peak latency of the N290 component. No main effects emerged on N290 mean amplitudes for stimulus gender or child gender in any of the face emotion conditions (neutral: $p = .623$; happy: $p = .330$; fearful: $p = .638$). No significant interactions were found between stimulus gender and child gender on N290 mean amplitude for any of the face emotion conditions (neutral: $p = .241$; happy: $p = .849$; fearful: $p = .600$). N290 peak latency was negatively associated with age in the neutral and happy face conditions regardless of child or stimulus gender (neutral: $\beta = -.146$, $t(72) = -2.15$, $p = .035$; happy: $\beta = -.207$, $t(72) = -3.38$, $p = .001$). No significant effects in peak latency emerged on the fearful faces condition (smallest $p = .059$).

Table 6.4. Uncorrected test statistics of N290 mean amplitudes and peak latency with variables of interest.

Condition	Variable	N290 mean amplitudes (uV)			N290 peak latencies (ms)		
		β	*t*(df)	*p*	*β*	*t*(df)	*p*
Neutral	stimulus gender	-.020	-0.49 (72)	.623	-.012	-0.25 (72)	.804
	child gender	.032	0.45 (72)	.652	-.009	-0.13 (72)	.901
	age	-.045	-0.80 (71)	.426	-.146*	-2.15 (72)	.035
	stimulus gender*child gender	-.059	-1.18 (72)	.241	-.010	-0.17 (72)	.862
Happy	stimulus gender	-.085	-0.98 (72)	.330	.043	0.66 (72)	.514
	child gender	.101	0.97 (71)	.336	-.034	-0.49 (72)	.625
	age	.003	0.08 (71)	.939	-.207*	-3.38 (72)	.001
	stimulus gender*child gender	-.020	-0.19 (72)	.849	-.038	-0.48 (72)	.634
Fearful	stimulus gender	.037	0.47 (72)	.638	-.005	-0.10 (72)	.923
	child gender	.023	0.24 (72)	.813	-.085	-1.13 (71)	.264
	age	-.027	-0.48 (71)	.630	-.074	-1.10 (72)	.273
	stimulus gender*child gender	-.050	-0.53 (72)	.600	.101	1.55 (72)	.127

Note: For stimulus gender, male was coded as reference category. For child gender, boy functioned as reference category. $^{*}p < .05$

In the happy face condition, two outliers were identified. Repeating the analysis without these outliers revealed a significant main effect of stimulus gender on N290 mean amplitude ($\beta = -.103$, $t(70) = -2.26$, $p = .027$). N290 amplitudes were larger (i.e., more negative) for happy female faces than happy male faces. No changes were observed in the direction of effects or significance of the other main effects or the interaction between stimulus gender and child gender (smallest p = .102).

To examine whether the difference in N290 amplitudes was driven by the amplitude difference in the preceding P1 component, P1 amplitudes were included as a predictor in the N290 mean amplitude analyses. This resulted in a non-significant main effect of stimulus gender on N290 mean amplitudes (β = -.035, t(70) = -0.82, p = .417).

P400

Table 6.5 contains an overview of uncorrected test statistics for the P400 mean amplitude analyses. For all facial expressions, no significant main effect of stimulus gender (neutral: p = .217; happy: p = .416; fearful: p = .480) or interaction effect between stimulus gender and child gender (neutral: p = .375; happy: p = .696; fearful: p = .938) emerged.

Table 6.5. Uncorrected test statistics of P400 mean amplitudes with variables of interest.

Condition	Variable	β	t(df)	p
Neutral	stimulus gender	-.056	-1.25 (72)	.217
	child gender	-.028	-0.39 (71)	.700
	age	-.049	-0.80 (71)	.429
	stimulus gender*child gender	-.048	-0.89 (72)	.375
Happy	stimulus gender	-.084	-0.82 (72)	.416
	child gender	.050	0.55 (68)	.586
	age	-.019	-0.41 (71)	.680
	stimulus gender*child gender	-.049	-0.39 (72)	.696
Fearful	stimulus gender	.046	0.71 (72)	.480
	child gender	-.038	-0.51 (72)	.614
	age	-.028	-0.52 (71)	.605
	stimulus gender*child gender	-.006	-0.08 (72)	.938

Note: For stimulus gender, male was coded as reference category. For child gender, boy functioned as reference category.

Again, model residuals revealed two outliers during the happy face condition. Excluding these outliers led to a significant main effect of stimulus gender on P400 mean amplitudes during the happy face condition (β = -.103, t(70) = -2.63, p = .011). Male happy faces elicited larger P400 mean amplitudes than female happy faces. The interaction between stimulus gender and child gender remained non-significant (β = .083, $t(70)$ = 1.75, p = .085).

Since indications were found that the difference in P400 amplitude during the happy face condition may have resulted from earlier differences in ERP amplitudes between the male and female face condition, analyses were repeated with N290 amplitudes included as a predictor. This led to a non-significant main effect of stimulus gender on P400 amplitudes (β = -.029, $t(70)$ = -1.03, p = .309).

Nc

Table 6.6 contains an overview of the uncorrected test statistics for the Nc mean amplitude analyses per condition. During the neutral face condition, no main effect of stimulus gender was found (p = .891), and there was no significant interaction between stimulus gender and child gender observed (p = .542). During the happy face condition, the main effect of stimulus gender was non-significant (p = .694) as well as the interaction between child gender and stimulus gender on Nc amplitudes (p = .134). Lastly, no significant (interaction) effects emerged for fearful facial expressions with regard to stimulus gender (main effect: p = .786; interaction effect: p = .388).

Inspecting the model residuals for each analysis revealed three outliers in the neutral face condition and the happy face condition, and four outliers in the fearful face condition. Excluding the outliers in the Nc analysis for the neutral face condition did not change the previous results (smallest p = .505 for child gender). With regard to happy faces, excluding the outliers led to a significant interaction between child gender and stimulus gender (β = -.181, $t(69)$ = -2.09, p = .040). Post-hoc inspection of the interaction revealed a cross-over interaction effect that indicated that boys had larger (i.e., more negative) Nc responses toward male than female happy faces (β = .129, $t(33)$ = 1.81, p = .080) whereas girls had a larger Nc response to female than male happy faces (β = -.077, $t(36)$ = -1.17, p = .251; see Figure 6.3). However, these post-hoc comparisons in boys and girls were not statistically significant. Excluding outliers in the fearful face analysis did not change the previous results (smallest p = .536).

Figure 6.3. Nc amplitudes toward male and female happy faces, separate for boys and girls, collapsed across the six electrodes (FC1, FC2, Fz, C3, C4, and Cz).

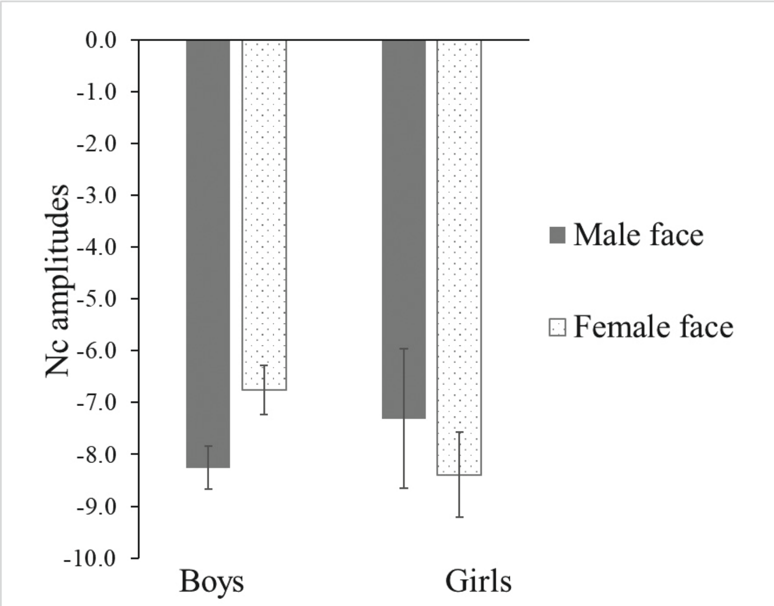


Table 6.6. Uncorrected test statistics of Nc mean amplitudes with variables of interest

Condition	Variable	*β*	*t*(df)	*p*
Neutral	stimulus gender	.009	0.14 (72)	.891
	child gender	.231	0.26 (72)	.794
	age	-.053	-0.68 (72)	.488
	stimulus gender*child gender	-.050	-0.61 (72)	.542
Happy	stimulus gender	.055	0.40 (72)	.694
	child gender	.185	1.43 (71)	.157
	age	.061	1.40 (72)	.165
	stimulus gender*child gender	-.257	-1.52 (72)	.134
Fearful	stimulus gender	-.027	-0.27 (72)	.786
	child gender	.010	0.08 (72)	.934
	age	.130	1.65 (72)	.102
	stimulus gender*child gender	.102	0.87 (72)	.388

Note: For stimulus gender, male was coded as reference category. For child gender, boy functioned as reference category.

Discussion

This study examined the neural responses of 3-year-old children toward male and female faces that violated or confirmed gender stereotypes regarding neutral, fearful, and happy facial expressions. The results provided preliminary evidence that children respond differently on a neural level to gender-stereotype violating and confirming emotions. First, there was some evidence that 3-year-olds responded differently on a neural level in response to happy men compared to happy women, demonstrated by elevated P1 amplitudes toward happy men when compared to happy women. Differences in N290 and P400 amplitudes toward male and female happy faces were additionally observed but these effects appeared to be driven by effects on the P1. Differences in ERP amplitudes were not found for men and women with a neutral facial expression, which confirmed our expectation that there would be no differences in the processing of neutral facial expressions for men and women. Lastly, one interaction with child gender was found, which indicated that girls showed larger Nc mean amplitude responses toward female happy faces than male happy faces, whereas boys showed larger Nc amplitude responses toward male happy faces than female happy faces. We did not find differences in neural processing of male and female faces with a fearful facial expression in any of the ERP components. Below, we discuss these preliminary findings in relation to previous studies.

We found some preliminary support that 3-year-old children process male and female emotional faces differently on a neural level, specifically when presented with a happy facial expression. For both boys and girls, this different neural processing was demonstrated in larger P1 mean amplitudes toward the stereotype-violating male happy faces compared to the stereotype-confirming female happy faces. Evidence of the role of the P1 in the face processing of children is mixed. For example, Todd et al. (2008) found no evidence for the role of the P1 in face processing, but other studies found larger P1 amplitudes toward affective than neutral faces (Vlamings et al., 2010) and emotional faces that violate gender stereotypes in adults (Liu et al., 2017). Our results are in line with the latter study. The P1 is thought to reflect the processing of lower-level features in the visual stimuli (Hillyard & Anllo-Vento, 1998). In addition, female faces are thought to naturally resemble a happy expression through their soft and round features (Slepian et al., 2011), whereas masculine facial features, such as a large forehead and square jaw, are more often associated with dominance and anger instead of happiness (Adams et al., 2014; Becker et al., 2007). Therefore, a happy facial expression would not resemble the male facial features, which could be interpreted as a distortion of the male face. The larger P1 response to happy male faces could thus reflect increased lower-level processing of a more ‘distorted’ stereotype-violating image when it concerns male faces displaying a happy facial expression.

Second, some indications were found that face-specific N290 and P400 components differed between male and female happy faces, but these differences disappeared when controlling for the preceding ERP amplitude differences. The N290 has been implicated in the categorization of a face as face-specific, prior to matching it to social categories such as gender, as it has been found to be larger toward human faces than monkey faces in infants (de Haan et al., 2003; Halit et al., 2003). Larger unadjusted N290 responses toward female happy faces might thus reflect increased familiarity with its facial expression, meaning that it might be easier to categorize a female happy face as a face than a male happy face. However, it seems likely that this effect resulted from the preceding P1 mean amplitude difference between male and female happy faces and should thus be interpreted with caution.

Moreover, the unadjusted P400 effect that was larger for stereotype-violating male happy faces fits with previous studies that have found the P400 to be larger for incongruent and unfamiliar stimuli. For example, larger P400 amplitudes were observed toward inverted than upright faces (Peykarjou et al., 2013), during trials in which there was a mismatch between target direction and a pointing hand direction (Melinder et al., 2015), toward stranger’s faces than caregiver’s faces (Carver et al., 2003; Moulson et al., 2009), and toward infrequent faces than frequent faces in an oddball paradigm (Xie et al., 2019). The current results add to this body of literature that P400 amplitudes also might be larger toward gender stereotype-violating emotional stimuli than to gender stereotype-confirming emotional stimuli. However, this effect may have also been carried over from the preceding N290 amplitude difference and should thus be interpreted cautiously.

Regarding the child’s own gender, we only found preliminary evidence for a difference between boys and girls in Nc amplitudes toward female and male happy faces. Both boys and girls appeared to have larger Nc amplitudes toward a same-gender happy faces than another-gender happy face. Previous research has also been inconsistent with regard to Nc responses toward familiar and unfamiliar faces. For example, Nc amplitudes have been found to be larger following familiar faces than unfamiliar faces (Bentin & Deouell, 2000; Eimer, 2000) and happy mothers’ than happy strangers’ faces (Todd et al., 2008). Similarly, another study showed that 1-year-olds had larger Nc responses toward their caregivers’ face than a stranger’s face (Carver et al., 2003), but that this pattern was reversed in older children (Carver et al., 2003; Moulson et al., 2009). So, it might be that the Nc is not a robust enough indicator of differential neural responses to gender-stereotype-violating and confirming emotional stimuli as well. The Nc component has mostly been implicated in attention toward salient stimuli, but which stimuli a child finds more salient might change over the course of development (de Haan et al., 2003; Hajcak et al., 2013). The current results may thus indicate that 3-year-olds might find a happy face from the same gender more salient compared to a happy face of the opposite gender. Moreover, despite indications that girls develop several types of gender schemas earlier than boys (Poulin-Dubois et al., 2002; Zosuls et al., 2009), this was not reflected in different neural processing of gender-stereotyped emotional stimuli between boys and girls.

Importantly, for faces with a neutral or fearful expression, we did not observe any differences in neural processing of male and female faces. This emphasizes that the differences we found in neural processing between male and female happy faces were not caused by general processing differences between male and female faces (Quinn et al., 2008). Although some have indicated that men present a more neutral facial expression than women at default (Fischer, 1993), no indications were found in children's neural responses toward neutral faces in the current sample. Moreover, evidence exists that people generally hold an own-gender bias, which is specifically observed in women and girls (Herlitz & Lovén, 2013), but evidence for an own-gender bias in young children is not conclusive. Our findings indicate that this own-gender bias is not yet present at the age of 3 years. This complements research using preferential looking paradigms that also did not find an own-gender bias effect in preverbal children (e.g., Hill & Flom, 2007; Serbin et al., 2002). There is some evidence that children of both genders at 3 - 5 months spend more time looking at female faces than male faces (Johnson et al., 2021; Quinn et al., 2002), but this preference is not yet present in newborns (Quinn et al., 2008) and this female face preference is no longer present at 7 months (Johnson et al., 2021).

With regard to the absence of gender differences in fearful facial expressions, this might indicate that children are less aware of the gendered nature of expressing fear compared to the gendered nature of expressing happiness. Evidence exists that parents are more likely to suppress negative emotions, such as anger and sadness, in front of their children, whereas they amplify positive emotions (Le & Impett, 2016). Especially during infancy and preschool years, parents function as the primary models for gender-role behaviors for their children (Bandura & Walters, 1977; Bussey & Bandura, 1999). If parents are more inclined to display happiness in front of their children, children might be more aware of the gendered nature of the display of happiness at such a young age.

Another explanation for the lack of differential processing of males and females in the fearful face condition could be that fearful faces are too ambiguous for young children. Previous research that examined the degree to which children accurately recognize emotional faces has indeed shown that young children are least accurate in recognizing fear (de Bordes et al., 2021; Porter et al., 2021). In these studies, children could accurately recognize happiness in happy faces (de Bordes et al., 2021; Porter et al., 2021). These difficulties in recognizing fear may have led to increased attentional processing that is necessary to decode fearful faces regardless of which gender expresses fear (Porter et al., 2021). In addition, children generally rely on basic cues to identify gender in faces, such as hair and clothing (Sugimura, 2006). Since the models with long hair had their hair pulled back in this picture, children might have been less able to differentiate between faces on the basis of hair cues.

Limitations and future research directions

Despite this study being the first to provide preliminary data on the contributions of both gender of the person displayed and gender of the child in ERP components among preschool children, it also comes with some caveats. First, nearly one third of children were excluded based on their EEG data quality. Although the excluded group did not differ from the included group in terms of demographic characteristics and this amount of data loss is not uncommon for EEG research in young children (van der Velde & Junge, 2020), the decrease in sample size could have made it more difficult to detect smaller effect sizes and to generalize the current findings. Second, the results found in this study did not survive multiple comparison corrections. Therefore, replication with larger sample sizes is needed to confirm these preliminary findings. Third, a confounding factor to consider for the current study was task order. The Face House task, which was used to obtain the neural responses toward neutral facial expressions, preceded the Face Emotion task during the lab visit. Although the three emotional face conditions have not been directly compared against one another, it is important to bear this limitation in mind when interpreting possible differences between the neutral face condition and the happy/fearful face conditions. Fourth, only three types of facial expressions were explored (neutral, happy, and fear). However, people also hold gendered expectations about other emotions, such as anger and sadness (Brody & Hall, 2008). Examining whether children also respond differently on a neural level toward men and women with an angry or sad facial expression would shed light on whether children also hold different gendered expectations about other emotions than happiness. Fifth, it is uncertain whether the children who participated in the EEG measurements recognized the presented emotions and whether they actually associated different emotions as more appropriate for one gender over the other. Additional assessment of children's gender stereotypes about emotions could provide insight as to whether the differences (or lack of differences) in processing of male and female emotional faces were indeed associated with children's stereotyped expectations about emotions. More information on whether children were accurate in decoding the facial expressions could also provide insights into why we did not find differential processing for fearful female and male faces. Last, it would be interesting to see if differences in neural processing of male and female emotional faces change over time and relate to a child's gender development or emotional development at a later age, and how the ways in which parents teach children about emotions may have contributed to children's differential processing of emotion expression.

Conclusion

The current study provided preliminary indications that children respond differently on a neural level to men and women who display happiness. In line with gender schema theories, our findings provide the first indications that 3-year-old children have developed cognitive frameworks that influence the way their brains process gender stereotyped content regarding emotion display. Specifically, in both boys and girls a happy facial expression appeared to elicit different attentional processing when it concerns a male face than a female face, whereas a similar differential response for fearful male and female facial expressions was not yet visible at this early age. These cognitive frameworks are likely to be reinforced as children grow older and their gender-stereotype knowledge increases. In addition, our study has indicated that EEG measurement might be able to provide insights into preschoolers' gender-stereotype knowledge about emotions, specifically by looking at the early occipital and late fronto-central temporal responses. This warrants future research to further explore whether similar brain responses to other types of gender-stereotypical information also occur in preverbal children and to increase knowledge of the development of gender stereotypes in early childhood. In practice, it seems important to increase awareness of how gendered cues from children's social environments contribute to the development of gender stereotypes in young children.

7

General discussion

General discussion

In order to increase our understanding of the predictors and consequences of parental gender socialization in early childhood the research for this dissertation had an interdisciplinary focus, combining perspectives and methods from different fields of research (neuroscience, psychology, gender, and parenting). The interdisciplinary field of neuroscience and gendered parenting is still largely unexplored. Yet both disciplines can benefit from more integration; the field of neuroscience by improving its ecological validity (Derks et al., 2013) and the field of gendered parenting by the ability to capture rapid and implicit processing of gender-related social stimuli (Parke, 2017). By combining these fields of research, we aimed to create a more comprehensive overview of processes that can explain the heterogeneity in evidence for parental gender socialization and its consequences for children's gender development across studies.

The different studies revealed several important characteristics and predictors of gendered socialization. In chapter 2, a review showed that multiple cognitive and neural factors were related to parents' employment of gender socialization in the home context (RQ1). For some of these cognitive (explicit/implicit gender stereotypes and attitudes, gendered attributions) and neural factors (attentional processing, conflict monitoring, reward processing) evidence was found for direct relations with parental gender socialization. Other cognitive factors, such as intergroup attitudes, gender essentialism, gender identity, conflict resolution, and internal motivation to parent without gender stereotypes have not yet been examined in relation to parental gender socialization but have been linked to gendered behaviors in general. In addition, brain processes related to behavior regulation were modulated by gender stereotypes, but have yet to be examined in the context of parental gender socialization.

Moreover, in this review we concluded that the different tasks and measurements that were used to capture the neural processing of gender stereotypes might explain different findings between studies and also makes comparison of findings across studies difficult. This was the inspiration for chapter 3, in which two frequently-used tasks were compared in their effectiveness to elicit differential neural processing of gender-stereotype violations and confirmations. The results in chapter 3 showed that the Impression Formation Task (IFT) appeared to elicit more robust congruence effects in the neural processing of gendered information in adults when compared to the Implicit Association Test (IAT) and was therefore recommended for neuroscientific research on gender stereotyping. In addition, non-parents showed gender-differentiated neural processing in P1, N1, and late positive potential (LPP) mean amplitudes but the strength and the direction of the effects depended on the participants' levels of gender stereotypes and attitudes, and whether a boy or a girl violated gender stereotypes.

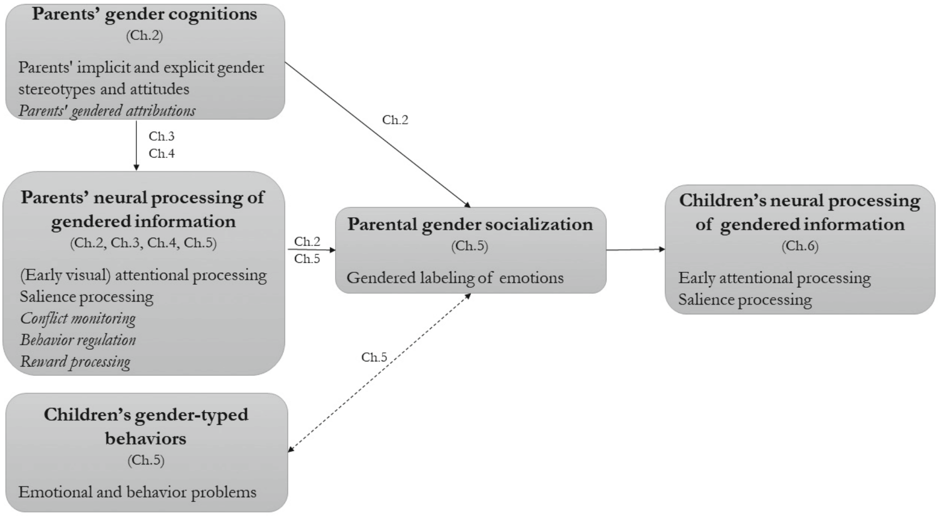
Next, the findings in chapter 3 motivated the use of the IFT in chapter 4 to examine parents' neural processing of gender-stereotype confirmations (e.g., aggressive boy) and violations (e.g., anxious boy) of parents' own and unknown children (RQ2). It was found that kinship to the child in the pictures did not modulate early attentional processing of gender-stereotype violations and confirmations, as demonstrated in the early occipital P1 component. Kinship did however play a role in salience processing; parents showed enhanced LPP mean amplitudes toward gender stereotype-violating behaviors when it concerned their own children versus unknown children. In addition, parents' early visual (P1) responses toward gender stereotype-violating child behaviors were stronger for boys than for girls, and for parents who evaluated gender-stereotype violations as less appropriate than gender-stereotype confirmations.

A following step was to examine whether these neural patterns of gender-stereotyped information processing were related to actual gender socialization practices of parents in the home context. In chapter 5, some evidence was found for the relation between parents' early occipital activity elicited by gender-stereotype confirmations by their own children and their use of gender labels during picture book reading (i.e., parental gender socialization). No evidence was found for the relation between children's gender-typed behaviors and parents' use of gender labels during picture book reading (RQ3).

Finally, to examine whether the consequences of parental gender socialization were visible in preschool children's gender stereotypes, it was investigated in chapter 6 whether 3-year-old children themselves already hold gender-stereotyped expectations about emotion expression (RQ4). The results indicated that 3-year-old children showed preliminary signs of gender stereotypes, as evidenced by differences in neural processing of male and female happy faces in early occipital (P1) and late fronto-temporal (Nc) components. Table 7.1 provides an overview of the main findings per chapter. Figure 7.1 includes a visualization of the findings in this dissertation.

In the next paragraphs, these main findings of chapter 2 - 6 are interpreted as possible predictors and consequences of parental gender socialization. Moreover, the meaning of the findings of this dissertation for within-family design studies on parental gender socialization are discussed. In addition, limitations of the studies included in this dissertation are discussed, as well as the research and practical implications of the findings and suggestions for future research.

Figure 7.1 Overview of the findings in each chapter and how the findings relate to each other across chapters.



Note. The solid lines indicate significant relations (chapter 3 – 5) or direct associations that were found in the literature overview (chapter 2). The dashed line indicates a non-significant association. Italic font indicates variables that were only identified through the literature review. Regular font indicates constructs that were empirically investigated in this dissertation.

Predictors of parental gender socialization

In the literature review in chapter 2, several cognitive and neural factors were identified that might underlie parental gender socialization. In chapter 3 – 5, the neural processing of gender-stereotyped information was examined and its relations to parental gender socialization were explored. Our interdisciplinary approach showed a number of key predictors of parental gender socialization concerning several cognitive and neural factors.

Cognitive predictors of parental gender socialization

In chapter 2, evidence is presented that parents' explicit and implicit gender stereotypes and attitudes are related to their gender socialization practices. Additional evidence was found for a relation between parents' gendered attributions and gender-differentiated parenting. Several other factors, such as gender essentialism, intergroup attitudes, gender identity, parents' motivation to parent without gender stereotypes, and conflict resolution were promising factors of interest, as these cognitive factors have been found to underlie other gendered behaviors. However, more research is needed to examine the direct associations between these cognitive factors and parental gender socialization.

Moreover, in chapter 3 and 4, implicit gender stereotypes and explicit gender attitudes modulated people's neural responses to gendered information. Both implicit and explicit gender stereotypes and attitudes were found to affect the earliest stages of visual processing of gender-stereotyped information in both parents and non-parental adults. In non-parents specifically, explicit gender attitudes additionally modulated salience processing of children's gender stereotypes. These cognitive predictors fit well with gender schema theories (GSTs) that posit that people's gender-related cognitions motivate their gendered behaviors (Bem, 1981, 1983; Martin & Halverson, 1981). Parents' gendered behaviors in this context would be the way that they employ gender socialization with their children. Moreover, gender cognitions might affect the way people process information from their social environments on a neural level, which is further elaborated on in the following section.

Neural predictors of parental gender socialization

In chapter 2 – 5, several neural factors were identified that might be related to parental gender socialization. First, from the literature reviewed in chapter 2, brain areas responsible for attentional processing, conflict monitoring, behavior regulation and reward processing were identified to be related to gendered behavior in general (Amodio, 2014; Stanley et al., 2008). In addition, two studies specifically examined neural processes in relation to gender socialization (Endendijk et al., 2019b; Mascaro et al., 2017). These studies found that neural conflict monitoring and reward processing were associated with mothers' gender stereotype-confirming comments and fathers' time spend in rough-and-tumble play with sons, respectively (Endendijk et al., 2019b; Mascaro et al., 2017). The role of the orbitofrontal cortex (reward processing) or dorsolateral/medial prefrontal cortex (behavior regulation) in parental gender socialization were not examined in the studies included in this dissertation. The role of conflict monitoring was examined but contrary to the study by Endendijk et al. (2019b), conflict monitoring was not significantly related to parental gender socialization in chapter 5. This might be due to the different domains in which gender socialization and neural processing of gender stereotypes were measured. The study reported in chapter 5 focused on gender stereotypes in the domain of problem behavior and included gender labeling of emotions as operationalization of gender socialization, whereas the study by Endendijk et al. (2019b) focused on the domain of toy preferences. Perhaps other mechanisms might play a more prominent role in parental gender socialization in the domain of emotions. For example, the findings in chapter 3-5 did provide evidence for the modulation of attentional processing of stereotypes, as evidenced by differences in the neural processing of gender-stereotype violations and confirmations in early visual processing and later salience processing. These components that were found to be modulated by gender stereotypes in this dissertation (i.e., the P1 and LPP) largely overlap with previous literature examining the neural processing of (gender) stereotypes (Dickter & Gyurovski, 2012; Liu et al., 2017; Proverbio et al., 2018; Rodríguez-Gómez et al., 2020) and are more elaborately discussed in the following paragraphs.

A consistent congruence effect was observed in early visual processing, as evidenced by the P1 mean amplitude, in both non-parents (chapter 3) and parents (chapter 4). This congruence effect entails that participants differentially processed information that confirmed (gender stereotype-congruent) versus violated (gender stereotype-incongruent) gender expectations. The congruence effect found for P1 mean amplitudes corroborates the role of attentional processing that was described in chapter 2. This effect could indicate that gender stereotype-violations about problem behavior require more visual processing than gender-stereotype confirmations about problem behavior. Moreover, findings in chapter 5 point toward a role for the early visual processing (P1) of gender-stereotyped emotions and behaviors and parents' use of gender labels, when taking into account whether parents are primed about the gendered nature of the study by participation in the observation task before the neural EEG assessment. Parental gender socialization was operationalized in this study as parents' use of gender labels (he, she, boy, girl, Peter, Lisa) to identify gender-neutral child characters displaying anger, sadness, or fear. This gender labelling is a form of gender socialization since it emphasizes the importance of gender for children and the appropriateness of certain emotions for each gender (Friedman et al., 2007).

The P1 peaks at approximately 80-135ms after stimulus presentation. The finding that gender stereotypes might affect this early stage of visual processing of information could be an indication of stereotyping being an implicit process that often happens automatically (Greenwald & Krieger, 2006; He et al., 2009). The gender-stereotyping of child problem behaviors might thus operate largely outside of our conscious minds. The interpretation that this differential early visual processing might reflect gender-stereotyping is strengthened by the finding that the P1 congruence effect depended on the participant's gender stereotypes and attitudes. A stronger P1 congruence effect was observed when (non-) parents had more traditional gender stereotypes and attitudes. This complements work by Healy et al. (2015) and Canal et al. (2015), who demonstrated that the neural patterns of implicit stereotypes depended on the participant's level of stereotypes or hostile sexism, respectively. The finding that P1 amplitudes could play a (small) role in parental gender socialization further extends the study by Endendijk et al. (2019b), in which a role of the N2 and P3 mean amplitudes in parents' evaluations of gendered behaviors was highlighted (see chapter 2). The small but significant role of parents' brain processes for parental gender socialization moreover illustrates the utility of neuroscience to better understand gendered parenting practices.

Salience processing also seemed to differ in parents' and non-parents' responses toward gender stereotype-violating and gender stereotype-confirming behaviors on a neural level. However, this effect was less stable across studies. In chapter 3, non-parents with stronger explicit gender attitudes had elevated LPP responses toward gender stereotype-confirming than gender stereotype-violating child stimuli paired with problem behaviors. In chapter 4, parents' LPP mean amplitudes were specifically larger toward gender stereotype-violating than gender stereotype-confirming child stimuli when it concerned their own, but not unknown children's problem behaviors. The LPP is a later neural component and is therefore assumed to reflect a more conscious processing of gendered information. The LPP has previously been found to differ depending on the salience of gender stereotypes (Rodríguez-Gómez et al., 2020). Parents and non-parents might find different elements of children's gendered behaviors salient. Non-parents with more traditional gender attitudes about behavior may show a preference of gender-conforming behaviors for children. Parents' stronger responses toward their own children's gender stereotype-violating behaviors might indicate an increased awareness of the social backlash that they or their children can experience from displaying gender non-conforming behaviors (Skewes et al., 2018; Sullivan et al., 2018). Non-parents might have less knowledge and might be less aware of the consequences of gender-stereotype violations or find the consequences less important or relevant to them, and thus might find nonconforming behaviors for children less salient. It thus seems that parental status and kinship appear to play a role in defining the level of salience of gender-stereotype violations and confirmations.

It is important to note that in chapter 3 and 4 no congruence effects were observed in the neural processing of gender stereotypes about toy preferences. The lack of findings in the toy domain may be explained by the valence of the behavior words that were used as stimuli in this study. Bad events generally have a stronger impact on people than good events (Baumeister et al., 2001; Chen & Bargh, 1999); as such, the negative connotations that surround internalizing and externalizing problem behaviors might elicit stronger reactions in adults. Moreover, negative valenced words seem to require more extensive early visual processing as indicated by P1 mean amplitudes (Smith et al., 2003). Toys generally have a neutral or positive connotation and could therefore be considered less arousing by adults.

Children's gender-typed behavior as predictor of parental gender socialization

In chapter 5 it was examined whether children's gender-typed behavior and emotional expressions were related to parents' gender-differentiated emotion socialization. Gender differences in behavior and emotional expressions are prevalent in both the externalizing and internalizing domain. However, especially for internalizing behaviors and emotions, gender differences often are found to emerge in adolescence (Graber, 2004; Pfeifer & Allen, 2021). Gender differences in externalizing expressions, such as aggression and rule-breaking behaviors, emerge earlier in life (Endendijk et al., 2017). The study reported in chapter 5 did not find evidence for the role of children's gender-typed emotional and behavioral functioning in parents' use of gender labels to identify emotional gender-neutral child characters in a picture book. Reciprocity is generally assumed when examining the relations between parental gender socialization and children's gendered behaviors (Endendijk et al., 2018b) in which gender differences in child behaviors can also elicit gender-differentiated responses. Parents' gender schemas can additionally be fueled by information they obtain from their home environment and thus from their children's preferences and behaviors (Bem, 1981, 1983; Martin & Halverson, 1981). It therefore seemed likely that children's gender-typed behaviors are incorporated in the cognitive structures that guide parents' socialization practices.

The findings in chapter 5 however do not provide evidence for the association between children's gender-typed behaviors and parents' gender socialization strategies. This contradicts the study by Endendijk et al. (2017), who found that fathers used more gender-differentiated physical control strategies with boys than girls and that this was related to higher levels of aggression in boys than in girls a year later. One reason for this discrepancy might be that in general little evidence was found for parental gender socialization in chapter 5 (i.e., use of gender labels for the emotional characters). Moreover, no gender differences in children's internalizing and externalizing expressions were found and prevalence of children's internalizing and externalizing expressions was low, with few children showing expressions in a clinical range. One explanation for the lack of associations between parental gender socialization and gender differences in child emotional and behavioral functioning might be the way that these concepts were measured. We relied on short parent-report questionnaires to measure children's levels of internalizing and externalizing behavior and emotional expressions. Parents might be less aware of children's behavioral and emotional expressions, particularly the internalizing ones, or children might not yet be able to verbalize their experienced emotions at preschool ages. Both factors would thus lead to an underreporting of children's emotional and behavioral problems. Using multiple informants (e.g., teachers, grandparents, etc.) and more elaborate questionnaires (e.g., CBCL; Achenbach, 1999) could provide a more reliable estimate of internalizing and externalizing behaviors in preschool children. Moreover, parents' use of gender labels was infrequent and only the sad, but not the fearful or angry child characters elicited a significant difference in the use of gender labels in parents (label girl > label boy). It might be that the picture book method was not as effective to elicit gendered communication in parents as previously thought (Endendijk et al., 2014; van der Pol et al., 2015).

Another reason that no parental gender socialization or gender differences in children's emotional and behavioral expressions were observed might be due to the family constellation of the included families. The Parenting Beyond Pink & Blue project (of which data was used for the studies reported in chapter 4 and 5) included only families with at least one son and one daughter aged 3-6 years. With regard to the lack of gender differences in emotional expressions, it might be that the other-gender sibling functions as an exemplar of other-gender behaviors that the child can model (Bandura, 1969; Bandura & Walters, 1963; Bussey & Bandura, 1999). When children display more other-gender behaviors, parents might be more familiar with both genders displaying similar behaviors and emotions (e.g., be more familiar with both girls and boys being scared or angry). This increased familiarity with different emotional displays in both genders might have decreased the likelihood that parents resorted to gender-stereotyped labeling of emotions. It thus seems that mixed-gender siblings might indeed have a gender-neutralizing effect on the family system, meaning that parents raising children from both genders are less likely to employ gender-differentiated parenting strategies. This is in agreement with previous work on mixed- versus same-gender sibling family constellations in early childhood (Endendijk et al., 2013; Endendijk et al., 2014).

Consequences of parental gender socialization

Although this dissertation primarily focused on the predictors of parental gender socialization, some conclusions can also be drawn with regard to the possible consequences of parental gender socialization for children's gender development from the findings of chapter 5 and 6. There is ample evidence from previous studies that show how different types of parental gender socialization are related to children's gender-typed behaviors in early and middle childhood (for an overview, see Morawska, 2020). For example, parents' gendered work and household division is related to children's career aspirations in middle childhood (Endendijk & Portengen, 2021). In addition, parents paid more attention toward girls' than boys' internalizing emotions (e.g., sadness and fear), which in turn was related to children's levels of internalizing emotions two years later (Chaplin et al., 2005). It thus seemed likely that parental gender socialization would be reflected in young children's gender-typed behaviors and gender stereotypes in the current dissertation as well (Endendijk et al., 2018b). As discussed in the previous section, parents' use of gender labels for emotional child characters was not related to their son's and daughter's internalizing and externalizing expressions. This contradicts earlier work on the relations between parental gender socialization and children's emotional and behavioral functioning (Chaplin et al., 2005; Zhu et al., 2023). The included family constellation (mixed-gender sibling dyads) or differences in the way that concepts were measured might explain why our findings did not align with previous studies. These explanations have been discussed in detail in the previous section.

In chapter 6, preliminary evidence is presented for the presence of gender stereotypes in 3-year-old children's neural responses toward emotional faces. First, preliminary evidence was found for increased early visual processing (P1) of male happy faces when compared to female happy faces. This replicates findings from chapter 3 and 4 with adult samples. Once again, there were indications that gender stereotyping was visible in the earliest processing of visual information. Second, Nc mean amplitudes were larger toward same-gender happy faces than other-gender happy faces (i.e., larger toward male happy faces in boys, larger toward female happy faces in girls). The Nc, similar to the adult LPP, is thought to represent salience processing in children. The finding that Nc mean amplitudes were larger toward same-gender happy faces thus might indicate that same-gender happy faces are evaluated as more salient in children. No gender differences were found in the processing of neutral or fearful facial expressions.

The findings in chapter 6 indicate that 3-year-old children already possess gender schematic knowledge. According to the GSTs (Bem, 1981, 1983; Martin & Halverson, 1981), gender schemas affect how children process gendered information and to which gender information children attend to. Children's gender schemas are based on what they learn about gender in their family through for example parental gender socialization. Moreover, the early differential processing of happy faces in 3-year-old children appear to reflect implicit gender stereotypes, since it occurs within 100ms after a child is presented with the gendered information. This is in line with a recent study by Gonzalez et al. (2022), who also found that children aged 3 – 7 years already show signs of implicit gender stereotyping. It is important to gain more understanding about the (early) development of gender stereotyping, since knowledge of gender stereotypes and gender categories has been found to affect preschool children's social behaviors (Halim et al., 2017). That 3-year-old children already possess gender-stereotyped knowledge is not a new finding (Eichstedt et al., 2002; Poulin-Dubois et al., 2002; Serbin et al., 2001; Serbin et al., 2002). However, the application of EEG measurements to examine gender stereotypes provides more information about the temporal dynamics and underlying processes that might affect children's perception of gendered information.

Limitations and future research recommendations

Some general limitations must be mentioned. First, the tasks administered in both the adult and child EEG measurements are sensitive to attention loss. In children, we accounted for distraction by using videotapes that recorded children's looking behaviors, and by excluding trials in which children did not pay attention to the stimulus. However, in the adult samples, looking behavior was not recorded. Since the adult EEG task took a long time to be completed (20 minutes in non-parents, 40 minutes for parents), loss of focus may have occurred during EEG data collection. The length of the task was determined by the power needed to detect relevant ERPs using a passive viewing paradigm. We tried to optimize attention retainment by allowing participants to take breaks in between blocks of stimuli and by including pictures of parents' own children as stimuli in the task.

Moreover, both observational studies and neuroscientific studies are sensitive to noise that might obscure the effects of interest. For EEG studies, artifact removal and correcting for ocular and movement artifacts in data corrects for some of this noise. Importantly, in the Parenting Beyond Pink & Blue project, EEG measurements were obtained from parents' homes. The setting in which EEG measurements were obtained were not the same across participants, not in a sound-proof room, and thus an extra source of noise in the data. By using a large number of trials per condition (*n* = 30 per condition) and multiple electrodes to quantify each ERP, noise was kept at a minimum (Huffmeijer et al., 2014). Moreover, mean amplitudes are less sensitive to noise than for example peak amplitudes (Clayson et al., 2013). These precautions increase the reliability of the ERP data reported in this dissertation (Huffmeijer et al., 2014). Similarly, observational studies are also subjected to noise. Although the presence of an observer is known to have limited effects on parent-child interactions (Gardner, 2000), some parents participating in the Parenting Beyond Pink & Blue project have indicated that having a camera pointed toward them whilst they interact with their children felt unnatural to them. By conducting home visits, we aimed to increase the ecological validity of the observations and thus increasing the likelihood that the interactions observed are reflecting real-life behaviors (Gardner, 2000). The validated coding schemes that were used to code parent-child behaviors in chapter 5 and by training multiple coders to code behaviors have moreover minimized the effect of observer bias in the codings of behaviors. Nonetheless, using two sources of data that are known to be sensitive to noise can decrease our likelihood to find significant relations between measures.

Last, both the children and adults who participated in the studies in this dissertation are from primarily White, highly-educated families. Moreover, in the Parenting Beyond Pink & Blue project, only mixed-gender parent couples were included. Important is however that parental gender socialization appears to be more similar than different between cisgender and LGBTQ+ parents, with both groups showing individual differences in their strength and endorsement of essentialist and binary gender thinking (McGuire et al., 2016). Even more important may be that the meaning of gender and gendered expectations differs across different cultures, races, classes, or socioeconomic status (Al-Faham et al., 2019). Although in chapter 2 some of the studies included focused on Latinx families, there is still limited knowledge about the predictors and consequences of parental gender socialization in non-Western populations. I thus recommend future studies to take an intersectional approach for studying parental gender socialization, by trying to include parents with a more diverse background and by studying these processes across cultures. Moreover, future research could examine whether the same or different neural and cognitive processes that are highlighted in this dissertation can also explain gender socialization in more gender-diverse family constellations.

Research and practical implications

The findings in this dissertation advance theoretical knowledge about the cognitive and neural processes that underlie parental gender socialization. This knowledge can fuel interdisciplinary research to further examine the mechanisms underlying parental gender socialization as well as the consequences for children's gender development. Regarding the predictors of parental gender socialization, we learned that parents' levels of implicit and explicit gender cognitions might provide indications of whether they apply a more gender-egalitarian or a more traditional gendered rearing of sons and daughters. In addition, parents' implicit processing of gender-stereotyped information might provide indications of their likelihood to resort to gender stereotypes in their parenting behaviors. Since gender-stereotyped information appeared to be differentially processed in the earliest stage of neural visual processing, it is important to examine ways in which this differential processing can be counteracted. Moreover, the results have implications for the GSTs and gendered family process model (Bem, 1983; Endendijk et al., 2018b). The neural processes underlying gender stereotyping and gender socialization examined in this dissertation indeed provide evidence that (non-)parents and children form gender schemas that affect how they process gendered information in their social environments. We identified two elements of people's gender schemas, namely their gender cognitions and their differential neural processing of gendered information. In relation to the gendered family process model (Endendijk et al., 2018b), this dissertation provides evidence for a link between parents' gender cognitions and parental gender socialization. Moreover, evidence was found for the presence of gender schemas about emotions in young children. These gender schemas are consequently related to the way in which children perceive gendered information, creating a filter for gender-relevant and irrelevant information.

Regarding practical implications, this dissertation provides evidence for the need to make (non-)parents aware of their implicit gender stereotypes and transmission of these stereotypes onto children via their gender socialization practices. Awareness of such stereotypes and the effect they might have on one's behavior and children's development is an important first step towards changing one's behavior. Parents' levels of gender stereotypes are not static; instead, parents generally tend to become more rigid or flexible in their gender-stereotyped expectations over time (Endendijk et al., 2018a; Rogers et al., 2023). Moreover, the findings that parents in families with mixed-gender siblings do not engage in much gender-labeling of emotions could indicate that if parents are exposed to a wide range of behaviors and emotions of children of both genders, they might be less likely to employ gender-differentiated socialization strategies. Children whose parents hold more gender-egalitarian views have been found to show a delayed development of gender awareness and knowledge (Fagot & Leinbach, 1995; Rogers et al., 2023). This delay in gender knowledge in turn might promote more positive attitudes toward outgroup members in early childhood (Halim et al., 2017). Promoting gender-egalitarian views among parents might thus be a first step in reducing the socialization pressure parents put on young children to adhere to gender norms.

Moreover, evidence was mainly found for the role of gender stereotypes in the domain of behaviors and emotions in the neural processing of gender stereotypes and for parental gender socialization. Although gender differences in these domains are well-documented (Becker et al., 2007; Chaplin & Aldao, 2013), little research examines the consequences of these gender stereotypes on children's emotional and behavioral functioning. It is important to examine the contributions of parental gender socialization to children's mental health, especially regarding gender-related pressure and gender non-conformity. Ample evidence exists that children who do not conform to gender-stereotyped expectations are at greater risk to develop mental health problems, in part due to negative reactions from their social environments and felt pressure to conform to gender stereotypes (Egan & Perry, 2001; Jackson et al., 2021; Kane, 2006; Menon & Hannah-Fisher, 2019; Potter et al., 2021). More insight into the mechanisms that can explain parents' need to transfer gendered information onto children might provide better targets for interventions aimed at creating a more inclusive home environment for gender (non)conforming and gender-diverse children.

Conclusion

In sum, this dissertation provides support for the role of several predictors of parental gender socialization. The neural processes that appear to underlie parental gender socialization were primarily visible in early attentional processes, which might point toward the often implicit and subconscious associations that parents make between gender and certain behaviors and characteristics. In children, differences in the early moments of visual processing of gender-stereotype violations versus confirmations seem to be visible on a neural level at 3 years of age. Moreover, both adults and children additionally appeared to show signs of stereotyping in their neural processes related to salience processing, albeit with less consistency across children, non-parental adults, and parents in which factor this salience depended on (e.g., own vs. unknown child, gender attitudes, or same-gender vs. other-gender). The possible consequences of parental gender socialization are less uniform; parental gender socialization appeared unrelated to preschool children's emotional and behavioral functioning. However, 3-year-olds appeared to already have acquired some form of gender schemas about the gendered display of emotions, which is reflected in their neural processing of emotional faces. The formation and application of gender schemas is thought to temporally precede the development of behaviors (Zosuls et al., 2009). Yet, more interdisciplinary research is needed, combining neuroscience and longitudinal designs tracking child development, to examine when and how gender schemas are formed in early childhood and to capture the effects of gender schemas in preschool children.

Looking back on why some parents are more inclined to raise their children as gender neutral as possible whereas others throw extravagant gender-reveal parties, we can conclude from this dissertation that these parents might differ in their levels of gender stereotypes and attitudes, and their early neural processing of gender stereotypes. Parents who hold more traditional gender attitudes or whose brains more vigorously process gender-stereotype violations and confirmations might be more inclined for instance to throw gender-reveal parties instead of employing more gender-neutral parenting practices. On the other hand, parents with more gender-egalitarian views and whose brains tend to differentiate less between gender-stereotype confirmations and violations might be more likely to raise their child as gender neutral as possible.

Table 7.1. Summary of the main findings per chapter in response to each research question.

Ch.	RQ	Main findings

2	1	• Several cognitive processes were identified that are (possibly) related to parental gender socialization:
		  • Parents' implicit and explicit gender stereotypes and attitudes
		  • Parents' gendered attributions
		  • Intergroup attitudes
		  • Gender essentialism
		  • Internal motivation for parenting without gender stereotypes
		  • Gender identity
		  • Conflict resolution

		• Several neural processes were identified that are (possibly) related to parental gender socialization:
		  • Attentional processing
		  • Conflict monitoring
		  • Behavior regulation
		  • Reward processing

3	2	• The Impression Formation Task was better equipped to elicit neural processing effects of the violation of gendered expectations than the Implicit Association Test.
		• Gender of the stimulus modulated visual discrimination processing (N1) of gendered expectations: larger responses for violations than confirmations were found for boys but not for girls.
		• People with stronger implicit gender stereotypes showed increased early visual processing (P1) of gender-stereotype violations than confirmations.
		• People with more traditional gender attitudes showed enhanced salience processing (LPP) of gender-stereotype confirmations than violations.
4	2	• Parents showed enhanced salience processing (LPP) toward gender stereotype-violating behaviors compared to gender stereotype-confirming behaviors of their own children.
		• Parents directed more early visual processes (P1) toward gender stereotype-violating boy behavior combinations than gender stereotype-confirming boy-behavior combinations.
		• Parents with more traditional gender attitudes showed enhanced early visual processing (P1 of gender stereotype-violating behaviors compared to gender stereotype-confirming behaviors.
5	2 + 3	• Parents' early visual processing (P1) elicited by gender-stereotyped behavior confirmations of daughters was related to parental gender socialization.
		• Children's gender-typed behavioral and emotional expressions were not significantly related to parental gender socialization.
		• Task order appeared to modulate the relation between parents' early visual processing (P1) of gender-stereotyped information and their parental gender socialization.
6	4	• Preschool children showed enhanced early attentional processing (P1) of happy male faces when compared to happy female faces.
		• 3-year-old boys and girls showed enhanced salience processing (Nc) of same-gender happy faces when compared to other-gender happy faces.

References

A

Abele, A. E. (2003). The dynamics of masculine-agentic and feminine-communal traits: Findings from a prospective study. *Journal of Personality and Social Psychology, 85*(4), 768-776. https://doi.org/10.1037/0022-3514.85.4.768

Abreu, P. D. d., Andrade, R. L. d. P., Maza, I. L. d. S., Faria, M. G. B. F. d., Nogueira, J. d. A., & Monroe, A. A. (2022). Dynamics of primary social networks to support mothers, fathers, or guardians of transgender children and adolescents: A systematic review. *International Journal of Environmental Research and Public Health, 19*(13), 7941. https://doi.org/10.3390/ijerph19137941

Achenbach, T. M. (1999). The Child Behavior Checklist and related instruments. In M. E. Maruish (Ed.), *The use of psychological testing for treatment planning and outcome assessment* (pp. 429-466). NJ: Lawrence Erlbaum Associates Publishers.

Adams, R. B., Hess, U., & Kleck, R. E. (2014). The intersection of gender-related facial appearance and facial displays of emotion. *Emotion Review*, *7*(1), 5-13. https://doi.org/10.1177/1754073914544407

Åhs, J. W., Dhejne, C., Magnusson, C., Dal, H., Lundin, A., Arver, S., Dalman, C., & Kosidou, K. (2018). Proportion of adults in the general population of Stockholm county who want gender-affirming medical treatment. *PloS One*, *13*(10), e0204606. https://doi.org/10.1371/journal.pone.0204606

Al-Faham, H., Davis, A. M., & Ernst, R. (2019). Intersectionality: From theory to practice. *Annual Review of Law and Social Science*, *15*(1), 247-265. https://doi.org/10.1146/annurev-lawsocsci-101518-042942

Amodio, D. M. (2014). The neuroscience of prejudice and stereotyping. *Nature Reviews Neuroscience, 15*(10), 670-682. https://doi.org/10.1038/nrn3800

Amodio, D. M., Devine, P. G., & Harmon-Jones, E. (2008). Individual differences in the regulation of intergroup bias: The role of conflict monitoring and neural signals for control. *Journal of Personality and Social Psychology, 94*(1), 60. https://doi.org/10.1037/0022-3514.94.1.60

Amodio, D. M., & Swencionis, J. K. (2018). Proactive control of implicit bias: A theoretical model and implications for behavior change. *Journal of Personality and Social Psychology, 115*(2), 255. https://doi.org/10.1037/pspi0000128

Arnett, J. J. (2015). Socialization in emerging adulthood: From the family to the wider world, from socialization to self-socialization. In *Handbook of socialization: Theory and research, 2nd ed.* (pp. 85-108). The Guilford Press.

Averett, K. H. (2016). The gender buffet: LGBTQ parents resisting heteronormativity. *Gender & Society, 30*(2), 189-212. https://doi.org/10.1177/0891243215611370

Azizian, A., Freitas, A. L., Parvaz, M. A., & Squires, N. K. (2006). Beware misleading cues: Perceptual similarity modulates the N2/P3 complex. *Psychophysiology, 4*3(3), 253-260. https://doi.org/10.1111/j.1469-8986.2006.00409.x

B

Baker, J. K., Fenning, R. M., & Crnic, K. A. (2011). Emotion socialization by mothers and fathers: Coherence among behaviors and associations with parent attitudes and children's social competence. *Social Development*, *20*(2), 412-430. https://doi.org/10.1111/j.1467-9507.2010.00585.x

Bandura, A. (1969). Social-learning theory of identificatory processes. *Handbook of Socialization Theory and Research*, *213*, 262.

Bandura, A., & Walters, R. H. (1977). *Social learning theory* (Vol. 1). Prentice-hall Englewood Cliffs, NJ.

Banse, R., Gawronski, B., Rebetez, C., Gutt, H., & Bruce Morton, J. (2010). The development of spontaneous gender stereotyping in childhood: Relations to stereotype knowledge and stereotype flexibility. *Developmental Science*, *13*(2), 298-306. https://doi.org/10.1111/j.1467-7687.2009.00880.x

Barrett, L. F., Robin, L., Pietromonaco, P. R., & Eyssell, K. M. (1998). Are women the "more emotional" sex? Evidence from emotional experiences in social context. *Cognition and Emotion*, *12*(4), 555-578. https://doi.org/10.1080/026999398379565

Bartholow, B. D., & Dickter, C. L. (2007). Social cognitive neuroscience of person perception: A selective review focused on the event-related brain potential. In E. Harmon-Jones & P. Winkielman (Eds.), *Social neuroscience: Integrating biological and psychological explanations of social behavior* (pp. 376-400). Guilford Press.

Bastian, B., & Haslam, N. (2006). Psychological essentialism and stereotype endorsement. *Journal of Experimental Social Psychology, 42*(2), 228-235. https://doi.org/10.1016/j.jesp.2005.03.003

Bates, D., Maechler, M., Bolker, B., Walker, S., Christensen, R. H. B., Singmann, H., Dai, B., Scheipl, F., Grothendieck, G., & Green, P. (2018). Package 'lme4'. *Version, 1*, 17.

Bates, D., Sarkar, D., Bates, M. D., & Matrix, L. (2007). The lme4 package. *R package version, 2*(1), 74.

Batty, M., & Taylor, M. J. (2006). The development of emotional face processing during childhood. *Developmental Science*, *9*(2), 207-220. https://doi.org/10.1111/j.1467-7687.2006.00480.x

Baumeister, R. F., Bratslavsky, E., Finkenauer, C., & Vohs, K. D. (2001). Bad is stronger than good. *Review of General Psychology, 5*(4), 323-370. https://doi.org/10.1037//1089-2680.5.4.323

Bayet, L., Pascalis, O., Quinn, P. C., Lee, K., Gentaz, É., & Tanaka, J. W. (2015a). Angry facial expressions bias gender categorization in children and adults: Behavioral and computational evidence. *Frontiers in Psychology*, *6*(346). https://doi.org/10.3389/fpsyg.2015.00346

Bayet, L., Quinn, P. C., Tanaka, J. W., Lee, K., Gentaz, É., & Pascalis, O. (2015b). Face gender influences the looking preference for smiling expressions in 3.5-month-old human infants. *PloS One*, *10*(6), e0129812. https://doi.org/10.1371/journal.pone.0129812

Becker, D. V., Kenrick, D. T., Neuberg, S. L., Blackwell, K. C., & Smith, D. M. (2007). The confounded nature of angry men and happy women. *Journal of Personality and Social Psychology*, *92*(2), 179-190. https://doi.org/10.1037/0022-3514.92.2.179

Bell, R. Q. (1979). Parent, child, and reciprocal influences. *American Psychologist*, *34*(10), 821.

Bem, S. L. (1981). Gender schema theory: A cognitive account of sex typing. *Psychological Review, 88*(4), 354. https://doi.org/10.1037/0033-295X.88.4.354

Bem, S. L. (1983). Gender schema theory and its implications for child development: Raising gender-aschematic children in a gender-schematic society. *Signs: Journal of Women in Culture and Society, 8*(4), 598-616. https://doi.org/10.1086/493998

Bentin, S., Allison, T., Puce, A., Perez, E., & McCarthy, G. (1996). Electrophysiological studies of face perception in humans. *Journal of Cognitive Neuroscience*, *8*(6), 551-565. https://doi.org/10.1162/jocn.1996.8.6.551

Bentin, S., & Deouell, L. Y. (2000). Structural encoding and identification in face processing: ERP evidence for separate mechanisms. *Cognitive Neuropsychology*, *17*(1-3), 35-55. https://doi.org/10.1080/026432900380472

Berenbaum, S. A., Blakemore, J. E. O., & Beltz, A. M. (2011). A role for biology in gender-related behavior. *Sex Roles*, *64*(11), 804-825. https://doi.org/10.1007/s11199-011-9990-8

Bergstrom-Lynch, C. (2020). Free to be you and me, maybe: Lesbian, gay, bisexual, and transgender parents doing gender with their children. *Journal of Gender Studies, 29*(3), 282-294. https://doi.org/10.1080/09589236.2019.1635000

Bernat, E., Bunce, S., & Shevrin, H. (2001). Event-related brain potentials differentiate positive and negative mood adjectives during both supraliminal and subliminal visual processing. *International Journal of Psychophysiology, 42*(1), 11-34. https://doi.org/10.1016/S0167-8760(01)00133-7

Bhanot, R., & Jovanovic, J. (2005). Do parents' academic gender stereotypes influence whether they intrude on their children's homework? *Sex Roles, 52*(9-10), 597-607. https://doi.org/10.1007/s11199-005-3728-4

Bian, L., Leslie, S.-J., & Cimpian, A. (2017). Gender stereotypes about intellectual ability emerge early and influence children's interests. *Science*, *355*(6323), 389-391. https://doi.org/10.1126/science.aah6524

Bidet-Caulet, A., Barbe, P. G., Roux, S., Viswanath, H., Barthélémy, C., Bruneau, N., Knight, R. T., & Bonnet-Brilhault, F. (2012). Dynamics of anticipatory mechanisms during predictive context processing. *European Journal of Neuroscience, 36*(7), 2996-3004. https://doi.org/10.1111/j.1460-9568.2012.08223.x

Biever, J. L., Fuentes, C. D. L., Cashion, L., & Franklin, C. (1998). The social construction of gender: A comparison of feminist and postmodern approaches. *Counselling Psychology Quarterly*, *11*(2), 163-179. https://doi.org/10.1080/09515079808254052

Biosemi activetwo.[EEG system]. (2011). BioSemi, B. [Mobile application software]

Birnbaum, D. W., & Chemelski, B. E. (1984). Preschoolers' inferences about gender and emotion: The mediation of emotionality stereotypes. *Sex Roles*, *10*(7), 505-511. https://doi.org/10.1007/BF00287259

Blakemore, J. E. O., Berenbaum, S. A., & Liben, L. S. (2008). *Gender development*. Psychology Press. https://doi.org/10.1002/9780470147658.chpsy0314

Blakemore, J. E. O., & Centers, R. E. (2005). Characteristics of boys' and girls' toys. *Sex Roles, 53*(9-10), 619-633. https://doi.org/10.1007/s11199-005-7729-0

Bluemke, M., & Friese, M. (2008). Reliability and validity of the single-target IAT (st-IAT): Assessing automatic affect towards multiple attitude objects. *European Journal of Social Psychology, 38*(6), 977-997. https://doi.org/10.1002/ejsp.487

Bornstein, M. H., Arterberry, M. E., & Mash, C. (2013). Differentiated brain activity in response to faces of "own" versus "unfamiliar" babies in primipara mothers: An electrophysiological study. *Developmental Neuropsychology, 38*(6), 365-385. https://doi.org/10.1080/87565641.2013.804923

Bozdogan, H. (1987). Model selection and Akaike's information criterion (AIC): The general theory and its analytical extensions. *Psychometrika, 52*(3), 345-370.

Bradley, G. W. (1978). Self-serving biases in the attribution process: A reexamination of the fact or fiction question. *Journal of Personality and Social Psychology, 36*, 56-71. https://doi.org/10.1037/0022-3514.36.1.56

Brassell, A. A., Rosenberg, E., Parent, J., Rough, J. N., Fondacaro, K., & Seehuus, M. (2016). Parent's psychological flexibility: Associations with parenting and child psychosocial well-being. *Journal of Contextual Behavioral Science*, *5*(2), 111-120. https://doi.org/10.1016/j.jcbs.2016.03.001

Breton, A., Ligneul, R., Jerbi, K., George, N., Baudouin, J.-Y., & Van der Henst, J.-B. (2019). How occupational status influences the processing of faces: An EEG study. *Neuropsychologia*, *122*, 125-135. https://doi.org/10.1016/j.neuropsychologia.2018.09.010

Brody, L. R., & Hall, J. A. (2008). Gender and emotion in context. *Handbook of emotions*, *3*, 395-408.

Brown, S. B., van Steenbergen, H., Band, G. P., de Rover, M., & Nieuwenhuis, S. (2012). Functional significance of the emotion-related late positive potential. *Frontiers in Human Neuroscience*, *6*, 33. https://doi.org/10.3389/fnhum.2012.00033

Bugental, D. B., & Corpuz, R. (2019). Parental attributions. In *Handbook of parenting: Being and becoming a parent, vol. 3, 3rd ed*. (pp. 722-761). Routledge/Taylor & Francis Group. https://doi.org/10.4324/9780429433214-21

Bugental, D. B., & Johnston, C. (2000). Parental and child cognitions in the context of the family. *Annual Review of Psychology, 51*(1), 315-344. https://doi.org/10.1146/annurev.psych.51.1.315

Bumpus, M. F., Crouter, A. C., & McHale, S. M. (2001). Parental autonomy granting during adolescence: Exploring gender differences in context. *Developmental Psychology, 37*(2), 163-173. https://doi.org/10.1037/0012-1649.37.2.163

Bussey, K., & Bandura, A. (1984). Influence of gender constancy and social power on sex-linked modeling. *Journal of Personality and Social Psychology, 47*(6), 1292. https://doi.org/10.1037/0022-3514.47.6.1292

Bussey, K., & Bandura, A. (1999). Social cognitive theory of gender development and differentiation. *Psychological Review, 106*(4), 676. https://doi.org/10.1037/0033-295X.106.4.676

Butz, D. A., & Plant, E. A. (2009). Prejudice control and interracial relations: The role of motivation to respond without prejudice. *Journal of Personality, 77*(5), 1311-1342. https://doi.org/10.1111/j.1467-6494.2009.00583.x

C

Canal, P., Garnham, A., & Oakhill, J. (2015). Beyond gender stereotypes in language comprehension: Self sex-role descriptions affect the brain's potentials associated with agreement processing. *Frontiers in Psychology, 6*(1953). https://doi.org/10.3389/fpsyg.2015.01953

Carver, L. J., Dawson, G., Panagiotides, H., Meltzoff, A. N., McPartland, J., Gray, J., & Munson, J. (2003). Age-related differences in neural correlates of face recognition during the toddler and preschool years. *Developmental Psychobiology*, *42*(2), 148-159. https://doi.org/10.1002/dev.10078

Cassano, M. C., & Zeman, J. L. (2010). Parental socialization of sadness regulation in middle childhood: The role of expectations and gender. *Developmental Psychology*, *46*, 1214-1226. https://doi.org/10.1037/a0019851

Castleberry, J. (2019). Addressing the gender continuum: A concept analysis. *Journal of Transcultural Nursing*, *30*(4), 403-409. https://doi.org/10.1177/1043659618818722

Cattaneo, Z., Mattavelli, G., Platania, E., & Papagno, C. (2011). The role of the prefrontal cortex in controlling gender-stereotypical associations: A TMS investigation. *Neuroimage, 56*(3), 1839-1846. https://doi.org/10.1016/j.neuroimage.2011.02.037

Chaplin, T. M., & Aldao, A. (2013). Gender differences in emotion expression in children: A meta-analytic review. *Psychological Bulletin, 139*(4), 735-765. https://doi.org/ 10.1037/a0030737

Chaplin, T. M., Cole, P. M., & Zahn-Waxler, C. (2005). Parental socialization of emotion expression: Gender differences and relations to child adjustment. *Emotion, 5*(1), 80. https://doi.org/10.1037/1528-3542.5.1.80

Chen, M., & Bargh, J. A. (1999). Consequences of automatic evaluation: Immediate behavioral predispositions to approach or avoid the stimulus. *Personality and Social Psychology Bulletin*, *25*(2), 215-224. https://doi.org/10.1177/0146167299025002007

Chorpita, B. F., Reise, S., Weisz, J. R., Grubbs, K., Becker, K. D., & Krull, J. L. (2010). Evaluation of the Brief Problem Checklist: Child and caregiver interviews to measure clinical progress. *Journal of Consulting and Clinical Psychology*, *78*, 526-536. https://doi.org/10.1037/a0019602

Clayson, P. E., Baldwin, S. A., & Larson, M. J. (2013). How does noise affect amplitude and latency measurement of event-related potentials (ERPs)? A methodological critique and simulation study. *Psychophysiology*, *50*(2), 174-186. https://doi.org/10.1111/psyp.12001

Cloutier, J., Gabrieli, J. D., O'Young, D., & Ambady, N. (2011). An fMRI study of violations of social expectations: When people are not who we expect them to be. *Neuroimage, 57*(2), 583-588. https://doi.org/10.1016/j.neuroimage.2011.04.051

Cohen, J. (2013). Statistical power analysis for the behavioral sciences. Academic press.

Clayson, P. E., Carbine, K. A., Baldwin, S. A., & Larson, M. J. (2019). Methodological reporting behavior, sample sizes, and statistical power in studies of event-related potentials: Barriers to reproducibility and replicability. *Psychophysiology, 56*(11), e13437. https://doi.org/10.1111/psyp.13437

Crowley, K., Callanan, M. A., Tenenbaum, H. R., & Allen, E. (2001). Parents explain more often to boys than to girls during shared scientific thinking. *Psychological Science, 12*(3), 258-261. https://doi.org/10.1111/1467-9280.00347

Cunningham, W. A., Johnson, M. K., Raye, C. L., Gatenby, J. C., Gore, J. C., & Banaji, M. R. (2004). Separable neural components in the processing of black and white faces. *Psychological Science*, *15*(12), 806-813. https://doi.org/10.1111/j.0956-7976.2004.00760.x

Cvencek, D., Meltzoff, A. N., & Greenwald, A. G. (2011). Math–gender stereotypes in elementary school children. *Child Development*, *82*(3), 766-779. https://doi.org/10.1111/j.1467-8624.2010.01529.x

D

Darley, J. M., & Gross, P. H. (1983). A hypothesis-confirming bias in labeling effects. *Journal of Personality and Social Psychology*, *44*, 20-33. https://doi.org/10.1037/0022-3514.44.1.20

Dawson, G., Webb, S. J., Carver, L., Panagiotides, H., & McPartland, J. (2004). Young children with autism show atypical brain responses to fearful versus neutral facial expressions of emotion. *Developmental Science*, *7*(3), 340-359. https://doi.org/10.1111/j.1467-7687.2004.00352.x

de Bordes, P. F., Hasselman, F., & Cox, R. F. A. (2021). Children's perception of facial expressions. *Developmental Psychology*, *57*(4), 506-518. https://doi.org/10.1037/dev0000979

de Haan, M., Johnson, M. H., & Halit, H. (2003). Development of face-sensitive event-related potentials during infancy: A review. *International Journal of Psychophysiology*, *51*(1), 45-58. https://doi.org/10.1016/S0167-8760(03)00152-1

de Haan, M., Nelson, C. A., Gunnar, M. R., & Tout, K. A. (1998). Hemispheric differences in brain activity related to the recognition of emotional expressions by 5-year-old children. *Developmental Neuropsychology*, *14*(4), 495-518. https://doi.org/10.1080/87565649809540725

DeCecco, J. P., & Elia, J. P. (1993). A critique and synthesis of biological essentialism and social constructionist views of sexuality and gender. *Journal of Homosexuality, 24*(3-4), 1-26. https://doi.org/10.1300/J082v24n03_01

Demiralp, T., Ademoglu, A., Comerchero, M., & Polich, J. (2001). Wavelet analysis of P3a and P3b. *Brain Topography, 13*(4), 251-267. https://doi.org/10.1023/A:1011102628306

Denner, J., Laursen, B., Dickson, D., & Hartl, A. C. (2016). Latino children's math confidence: The role of mothers' gender stereotypes and involvement across the transition to middle school. *Journal of Early Adolescence, 38*(4), 513-529. https://doi.org/10.1177/0272431616675972

Derks, B., Scheepers, D., & Ellemers, N. (2013). *Neuroscience of prejudice and intergroup relations.* Psychology Press. https://doi.org/10.4324/9780203124635

Devine, P. G., Plant, E. A., Amodio, D. M., Harmon-Jones, E., & Vance, S. L. (2002). The regulation of explicit and implicit race bias: The role of motivations to respond without prejudice. *Journal of Personality and Social Psychology*, *82*(5), 835. https://doi.org/10.1037/0022-3514.82.5.835

Di Lorenzo, R., van den Boomen, C., Kemner, C., & Junge, C. (2020). Charting development of ERP components on face-categorization: Results from a large longitudinal sample of infants. *Developmental Cognitive Neuroscience*, *45*, 100840. https://doi.org/10.1016/j.dcn.2020.100840

Di Russo, F., Martínez, A., & Hillyard, S. A. (2003). Source analysis of event-related cortical activity during visuo-spatial attention. *Cerebral Cortex*, *13*(5), 486-499. https://doi.org/10.1093/cercor/13.5.486

Dickter, C., & Gyurovski, I. (2012). The effects of expectancy violations on early attention to race in an impression-formation paradigm. *Social Neuroscience, 7*(3), 240-251. https://doi.org/10.1080/17470919.2011.609906

Dinella, L. M., Fulcher, M., & Weisgram, E. S. (2014). Sex-typed personality traits and gender identity as predictors of young adults' career interests. *Archives of Sexual Behavior, 43*(3), 493-504. https://doi.org/10.1007/s10508-013-0234-6

Dittman, C. K., Sprajcer, M., & Turley, E. L. (2022). Revisiting gendered parenting of adolescents: Understanding its effects on psychosocial development. *Current Psychology, 42,* 24569–24581. https://doi.org/10.1007/s12144-022-03536-7

Doi, H., & Shinohara, K. (2012). Event-related potentials elicited in mothers by their own and unfamiliar infants' faces with crying and smiling expression. *Neuropsychologia*, *50*(7), 1297-1307. https://doi.org/10.1016/j.neuropsychologia.2012.02.013

DuBois, L. Z., Gibb, J. K., Juster, R.-P., & Powers, S. I. (2021). Biocultural approaches to transgender and gender diverse experience and health: Integrating biomarkers and advancing gender/sex research. *American Journal of Human Biology*, *33*(1), e23555. https://doi.org/10.1002/ajhb.23555

Duhig, A. M., Renk, K., Epstein, M. K., & Phares, V. (2000). Interparental agreement on internalizing, externalizing, and total behavior problems: A meta-analysis. *Clinical Psychology: Science and Practice, 7*(4), 435-453. https://doi.org/10.1093/clipsy.7.4.435

Dumas, M. D. (2014). *Gender neutral parenting: An argument for a place on the contemporary feminist agenda* [Unpublished dissertation]. Southern Connecticut State University.

Dunham, Y., Baron, A. S., & Banaji, M. R. (2016). The development of implicit gender attitudes. *Developmental Science, 19*(5), 781-789. https://doi.org/10.1111/desc.12321

Duval, E. R., Moser, J. S., Huppert, J. D., & Simons, R. F. (2013). What's in a face? *Journal of Psychophysiology, 27*(1), 27-38. https://doi.org/10.1027/0269-8803/a000083

E

Eccles, J. S., Jacobs, J. E., & Harold, R. D. (1990). Gender role stereotypes, expectancy effects, and parents' socialization of gender differences. *Journal of Social Issues*, *46*(2), 183-201. https://doi.org/10.1111/j.1540-4560.1990.tb01929.x

Egan, S. K., & Perry, D. G. (2001). Gender identity: A multidimensional analysis with implications for psychosocial adjustment. *Developmental Psychology*, *37*, 451-463. https://doi.org/10.1037/0012-1649.37.4.451

Eichstedt, J. A., Serbin, L. A., Poulin-Dubois, D., & Sen, M. G. (2002). Of bears and men: Infants' knowledge of conventional and metaphorical gender stereotypes. *Infant Behavior and Development*, *25*(3), 296-310. https://doi.org/10.1016/S0163-6383(02)00081-4

Eimer, M. (2000). Event-related brain potentials distinguish processing stages involved in face perception and recognition. *Clinical Neurophysiology*, *111*(4), 694-705. https://doi.org/10.1016/S1388-2457(99)00285-0

Eisenberg, N., Cumberland, A., & Spinrad, T. L. (1998). Parental socialization of emotion. *Psychological Inquiry*, *9*(4), 241-273. https://doi.org/10.1207/s15327965pli0904_1

Else-Quest, N. M., Hyde, J. S., Goldsmith, H. H., & Van Hulle, C. A. (2006). Gender differences in temperament: A meta-analysis. *Psychological Bulletin, 132*(1), 33-72. https://doi.org/10.1037/0033-2909.132.1.33

Endendijk, J. J. (2022). Welcome to a pink and blue world! An analysis of gender-typed content in birth announcement cards from 1940-2019 in the Netherlands. *Sex Roles*, *86*(1), 1-13. https://doi.org/10.1007/s11199-021-01249-y

Endendijk, J. J., Derks, B., & Mesman, J. (2018a). Does parenthood change implicit gender-role stereotypes and behaviors? *Journal of Marriage and Family*, 80(1), 61-79. https://doi.org/10.1111/jomf.12451

Endendijk, J. J., Groeneveld, M. G., Bakermans-Kranenburg, M. J., & Mesman, J. (2016). Gender-differentiated parenting revisited: Meta-analysis reveals very few differences in parental control of boys and girls. *PloS One*, *11*(7). https://doi.org/10.1371/journal.pone.0159193

Endendijk, J. J., Groeneveld, M. G., & Mesman, J. (2018b). The gendered family process model: An integrative framework of gender in the family. *Archives of Sexual Behavior*, *47*(4), 877-904. https://doi.org/10.1007/s10508-018-1185-8

Endendijk, J. J., Groeneveld, M. G., van Berkel, S. R., Hallers-Haalboom, E. T., Mesman, J., & Bakermans-Kranenburg, M. J. (2013). Gender stereotypes in the family context: Mothers, fathers, and siblings. *Sex Roles, 68*(9), 577-590. https://doi.org/10.1007/s11199-013-0265-4

Endendijk, J. J., Groeneveld, M. G., Van der Pol, L. D., Van Berkel, S. R., Hallers-Haalboom, E. T., Mesman, J., & Bakermans-Kranenburg, M. J. (2014). Boys don't play with dolls: Mothers' and fathers' gender talk during picture book reading. *Parenting, 14*(3-4), 141-161. https://doi.org/10.1080/15295192.2014.972753

Endendijk, J. J., Groeneveld, M. G., van der Pol, L. D., van Berkel, S. R., Hallers-Haalboom, E. T., Bakermans-Kranenburg, M. J., & Mesman, J. (2017). Gender differences in child aggression: Relations with gender-differentiated parenting and parents' gender-role stereotypes. *Child Development, 88*(1), 299-316. https://doi.org/10.1111/cdev.12589

Endendijk, J. J., & Portengen, C. M. (2021). Children's views about their future career and family involvement: Associations with children's gender schemas and parents' involvement in work and family roles. *Frontiers in Psychology, 12*, 789764. https://doi.org/10.3389/fpsyg.2021.789764

Endendijk, J. J., Smit, A. K., van Baar, A. L., & Bos, P. A. (2019a). Boys' toys, girls' toys: An fMRI study of mothers' neural responses to children violating gender expectations. *Biological Psychology, 148*, 107776. https://doi.org/10.1016/j.biopsycho.2019.107776

Endendijk, J. J., Spencer, H., Bos, P. A., & Derks, B. (2019b). Neural processing of gendered information is more robustly associated with mothers' gendered communication with children than mothers' implicit and explicit gender stereotypes. *Social Neuroscience, 14*(3), 300-312. https://doi.org/10.1080/17470919.2018.1468357

European Institute for Gender Equality. (2020). *Gender equality index.* Retrieved 15-5-2020 from https://eige.europa.eu/gender-equality-index/

Ex, C. T. G. M., & Janssens, J. M. A. M. (1998). Maternal influences on daughters' gender role attitudes. *Sex Roles, 38*(3-4), 171-186. https://doi.org/10.1023/A:1018776931419

F

Fabre, E. F., Causse, M., Pesciarelli, F., & Cacciari, C. (2015). Sex and the money – How gender stereotypes modulate economic decision-making: An ERP study. *Neuropsychologia, 75*, 221-232. https://doi.org/10.1016/j.neuropsychologia.2015.06.013

Fagot, B. I., & Leinbach, M. D. (1995). Gender knowledge in egalitarian and traditional families. *Sex Roles*, *32*(7-8), 513-526. https://doi.org/10.1007/BF01544186

Faul, F., Erdfelder, E., Buchner, A., & Lang, A.-G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods, 41*(4), 1149-1160. https://doi.org/10.3758/BRM.41.4.1149

Feldman, R. (2015). The adaptive human parental brain: Implications for children's social development. *Trends in Neurosciences, 38*(6), 387-399. https://doi.org/10.1016/j.tins.2015.04.004

Fischer, A. H. (1993). Sex differences in emotionality: Fact or stereotype? *Feminism & Psychology*, *3*(3), 303-318. https://doi.org/10.1177/0959353593033002

Fisher-Thompson, D. (1993). Adult toy purchases for children: Factors affecting sex-typed toy selection. *Journal of Applied Developmental Psychology*, *14*(3), 385-406. https://doi.org/10.1016/0193-3973(93)90016-O

Fivush, R., Brotman, M. A., Buckner, J. P., & Goodman, S. H. (2000). Gender differences in parent–child emotion narratives. *Sex Roles, 42*(3-4), 233-253. https://doi.org/10.1023/A:1007091207068

Fivush, R., & Buckner, J. P. (2000). Gender, sadness, and depression: The development of emotional focus through gendered discourse. In A. H. Fischer (Ed.), *Gender and emotion: Social psychological perspectives* (pp. 232-253). Cambridge University Press. https://doi.org/10.1017/CBO9780511628191.012

Forbes, C. E., Cameron, K. A., Grafman, J., Barbey, A. K., Solomon, J., Ritter, W., & Ruchkin, D. (2012). Identifying temporal and causal contributions of neural processes underlying the Implicit Association Test (IAT). *Frontiers in Human Neuroscience, 6*, 320. https://doi.org/10.3389/fnhum.2012.00320

Fortin, N. M. (2005). Gender role attitudes and the labour-market outcomes of women across OECD countries. *Oxford Review of Economic Policy, 21*(3), 416-438. https://doi.org/10.1093/oxrep/gri024

Freeman, N. K. (2007). Preschoolers' perceptions of gender appropriate toys and their parents' beliefs about genderized behaviors: Miscommunication, mixed messages, or hidden truths? *Early Childhood Education Journal*, *34*(5), 357-366. https://doi.org/10.1007/s10643-006-0123-x

Friedman, C. K., Leaper, C., & Bigler, R. S. (2007). Do mothers' gender-related attitudes or comments predict young children's gender beliefs? *Parenting: Science and Practice, 7*(4), 357-366. https://doi.org/10.1080/15295190701665656

G

Gardner, F. (2000). Methodological issues in the direct observation of parent–child interaction: Do observational findings reflect the natural behavior of participants? *Clinical Child and Family Psychology Review*, *3*(3), 185-198. https://doi.org/10.1023/A:1009503409699

Gaunt, R., & Pinho, M. (2018). Do sexist mothers change more diapers? Ambivalent sexism, maternal gatekeeping, and the division of childcare. *Sex Roles, 79*(3), 176-189. https://doi.org/10.1007/s11199-017-0864-6

Gawronski, B., & Bodenhausen, G. V. (2006). Associative and propositional processes in evaluation: An integrative review of implicit and explicit attitude change. *Psychological Bulletin, 132*(5), 692. https://doi.org/10.1037/0033-2909.132.5.692

Gawronski, B., Bodenhausen, G. V., Mitchell, C. J., De Houwer, J., & Lovibond, P. F. (2009). Operating principles versus operating conditions in the distinction between associative and propositional processes. *Behavioral and Brain Sciences, 32*(2), 207. https://doi.org/10.1017/S0140525X09000958

Gawronski, B., & Creighton, L. A. (2013). Dual process theories. In D. E. Carlston (Ed.), *Oxford library of psychology. The oxford handbook of social cognition*.

Gelman, S. A. (2003). The essential child: Origins of essentialism in everyday thought. Oxford Cognitive Development.

Gelman, S. A., Taylor, M. G., & Nguyen, S. P. (2004). Mother-child conversations about gender: Understanding the acquisition of essentialist beliefs. *Monographs of the Society for Research in Child Development*. https://doi.org/10.1111/j.1540-5834.2004.06901007.x

Gieseler, C. (2018). Gender-reveal parties: Performing community identity in pink and blue. *Journal of Gender Studies*, *27*(6), 661-671. https://doi.org/10.1080/09589236.2017.1287066

Gilbert, S. J., Swencionis, J. K., & Amodio, D. M. (2012). Evaluative vs. trait representation in intergroup social judgments: Distinct roles of anterior temporal lobe and prefrontal cortex. *Neuropsychologia, 50*(14), 3600-3611. https://doi.org/10.1016/j.neuropsychologia.2012.09.002

Goldberg, A. E. (2009). Heterosexual, lesbian, and gay preadoptive parents' preferences about child gender. *Sex Roles*, *61*(1), 55-71. https://doi.org/10.1007/s11199-009-9598-4

Gonzalez, A. M., Block, K., Oh, H. J. J., Bizzotto, R., & Baron, A. S. (2022). Measuring implicit gender stereotypes using the preschool auditory stroop. *Journal of Cognition and Development*, *23*(2), 254-272. https://doi.org/10.1080/15248372.2021.2013223

Glick, P., & Fiske, S. T. (1996). The ambivalent sexism inventory: Differentiating hostile and benevolent sexism. *Journal of Personality and Social Psychology*, *70*(3), 491-512. https://doi.org/10.1037/0022-3514.70.3.491

Graber, J. A. (2004). Internalizing problems during adolescence. In *Handbook of adolescent psychology* (pp. 587-626). https://doi.org/10.1002/9780471726746.ch19

Gratton, G., Coles, M. G., & Donchin, E. (1983). A new method for off-line removal of ocular artifact. *Electroencephalography & Clinical Neurophysiology, 55*(4), 468-484. https://doi.org/10.1016/0013-4694(83)90135-9

Greenwald, A. G., Banaji, M. R., Rudman, L. A., Farnham, S. D., Nosek, B. A., & Mellott, D. S. (2002). A unified theory of implicit attitudes, stereotypes, self-esteem, and self-concept. *Psychological Review, 109*(1), 3. https://doi.org/10.1037/0033-295X.109.1.3

Greenwald, A. G., & Krieger, L. H. (2006). Implicit bias: Scientific foundations. *California Law Review, 94*(4), 945-967. https://doi.org/10.2307/20439056

Greenwald, A. G., Nosek, B. A., & Banaji, M. R. (2003). Understanding and using the Implicit Association Test: I. An improved scoring algorithm. *Journal of Personality and Social Psychology, 85*(2), 197. https://doi.org/10.1037/0022-3514.85.2.197

Greenwald, A. G., & Pettigrew, T. F. (2014). With malice toward none and charity for some: Ingroup favoritism enables discrimination. *American Psychologist, 69*(7), 669-684. https://doi.org/10.1037/a0036056

Greenwald, A. G., Poehlman, T. A., Uhlmann, E. L., & Banaji, M. R. (2009). Understanding and using the Implicit Association Test: III. Meta-analysis of predictive validity. *Journal of Personality and Social Psychology, 97*(1), 17. https://doi.org/10.1037/a0015575

Grietens, H., Onghena, P., Prinzie, P., Gadeyne, E., Van Assche, V., Ghesquière, P., & Hellinckx, W. (2004). Comparison of mothers', fathers', and teachers' reports on problem behavior in 5- to 6-year-old children. *Journal of Psychopathology and Behavioral Assessment, 26*(2), 137-146. https://doi.org/10.1023/B:JOBA.0000013661.14995.59

Grossman, A. H., D'Augelli, A. R., Howell, T. J., & Hubbard, S. (2005). Parent' reactions to transgender youth' gender nonconforming expression and identity. *Journal of Gay & Lesbian Social Services*, *18*(1), 3-16. https://doi.org/10.1300/J041v18n01_02

Gunderson, E. A., Ramirez, G., Levine, S. C., & Beilock, S. L. (2012). The role of parents and teachers in the development of gender-related math attitudes. *Sex Roles*, *66*(3), 153-166. https://doi.org/10.1007/s11199-011-9996-2

Gyurovski, I., Kubota, J., Cardenas-Iniguez, C., & Cloutier, J. (2018). Social status level and dimension interactively influence person evaluations indexed by P300s. *Social Neuroscience, 13*(3), 333-345. https://doi.org/10.1080/17470919.2017.1326400

H

Hajcak, G., MacNamara, A., Foti, D., Ferri, J., & Keil, A. (2013). The dynamic allocation of attention to emotion: Simultaneous and independent evidence from the late positive potential and steady state visual evoked potentials. *Biological Psychology, 92*(3), 447-455. https://doi.org/10.1016/j.biopsycho.2011.11.012

Haines, E. L., Deaux, K., & Lofaro, N. (2016). The times are a-changing… or are they not? A comparison of gender stereotypes, 1983-2014. *Psychology of Women Quarterly, 40*(3), 353-363. https://doi.org/10.1177/0361684316634081

Halim, M. L. D., Ruble, D. N., Tamis-LeMonda, C. S., Shrout, P. E., & Amodio, D. M. (2017). Gender attitudes in early childhood: Behavioral consequences and cognitive antecedents. *Child Development*, *88*(3), 882-899. https://doi.org/10.1111/cdev.12642

Halpern, H. P., & Perry-Jenkins, M. (2016). Parents' gender ideology and gendered behavior as predictors of children's gender-role attitudes: A longitudinal exploration. *Sex Roles, 74*(11), 527-542. https://doi.org/10.1007/s11199-015-0539-0

Halit, H., de Haan, M., & Johnson, M. H. (2003). Cortical specialisation for face processing: Face-sensitive event-related potential components in 3- and 12-month-old infants. *Neuroimage*, *19*(3), 1180-1193. https://doi.org/10.1016/S1053-8119(03)00076-4

He, Y., Johnson, M. K., Dovidio, J. F., & McCarthy, G. (2009). The relation between race-related implicit associations and scalp-recorded neural activity evoked by faces from different races. *Social Neuroscience, 4*(5), 426-442. https://doi.org/10.1080/17470910902949184

Healy, G. F., Boran, L., & Smeaton, A. F. (2015). Neural patterns of the Implicit Association Test. *Frontiers in Human Neuroscience, 9*, 605. https://doi.org/10.3389/fnhum.2015.00605

Hehman, E., Carpinella, C. M., Johnson, K. L., Leitner, J. B., & Freeman, J. B. (2014a). Early processing of gendered facial cues predicts the electoral success of female politicians. *Social Psychological and Personality Science, 5*(7), 815-824. https://doi.org/10.1177/1948550614534701

Hehman, E., Ingbretsen, Z. A., & Freeman, J. B. (2014b). The neural basis of stereotypic impact on multiple social categorization. *Neuroimage, 101*, 704-711. https://doi.org/10.1016/j.neuroimage.2014.07.056

Hehman, E., Volpert, H. I., & Simons, R. F. (2014c). The N400 as an index of racial stereotype accessibility. *Social Cognitive and Affective Neuroscience, 9*(4), 544-552. https://doi.org/10.1093/scan/nst018

Heidari, S., Babor, T. F., De Castro, P., Tort, S., & Curno, M. (2016). Sex and gender equity in research: Rationale for the SAGER guidelines and recommended use. *Research Integrity and Peer Review, 1*(1), 2. https://doi.org/10.1186/s41073-016-0007-6

Heilman, M. E., Wallen, A. S., Fuchs, D., & Tamkins, M. M. (2004). Penalties for success: Reactions to women who succeed at male gender-typed tasks. *Journal of Applied Psychology, 89*(3), 416. https://doi.org/10.1037/0021-9010.89.3.416

Heisig, J. P., & Schaeffer, M. (2019). Why you should always include a random slope for the lower-level variable involved in a cross-level interaction. *European Sociological Review, 35*(2), 258-279. https://doi.org/10.1093/esr/jcy053

Henslin, J. M. (1981). Down to earth sociology: Introductory readings. Simon and Schuster.

Herlitz, A., & Lovén, J. (2013). Sex differences and the own-gender bias in face recognition: A meta-analytic review. *Visual Cognition*, *21*(9-10), 1306-1336. https://doi.org/10.1080/13506285.2013.823140

Hilgard, J., Bartholow, B. D., Dickter, C. L., & Blanton, H. (2014). Characterizing switching and congruency effects in the Implicit Association Test as reactive and proactive cognitive control. *Social Cognitive and Affective Neuroscience, 10*(3), 381-388. https://doi.org/10.1093/scan/nsu060

Hill, S. E., & Flom, R. (2007). 18- and 24-month-olds' discrimination of gender-consistent and inconsistent activities. *Infant Behavior and Development*, *30*(1), 168-173. https://doi.org/10.1016/j.infbeh.2006.08.003

Hillyard, S. A., & Anllo-Vento, L. (1998). Event-related brain potentials in the study of visual selective attention. *Proceedings of the National Academy of Sciences*, *95*(3), 781-787. https://doi.org/10.1073/pnas.95.3.781

Huffmeijer, R., Bakermans-Kranenburg, M. J., Alink, L. R., & Van IJzendoorn, M. H. (2014). Reliability of event-related potentials: The influence of number of trials and electrodes. *Hormones and Behavior, 130*, 13-22. https://doi.org/10.1016/j.yhbeh.2012.11.008

I

Irvine, J. M. (1990). From difference to sameness: Gender ideology in sexual science. *The Journal of Sex Research, 27*(1), 7-24. https://doi.org/10.1080/00224499009551539

Ito, T. A., Thompson, E., & Cacioppo, J. T. (2004). Tracking the timecourse of social perception: The effects of racial cues on event-related brain potentials. *Personality and Social Psychology Bulletin, 30*(10), 1267-1280. https://doi.org/10.1177/0146167204264335

J

Jackson, E. F., Bussey, K., & Myers, E. (2021). Encouraging gender conformity or sanctioning nonconformity? Felt pressure from parents, peers, and the self. *Journal of Youth and Adolescence*, *50*(4), 613-627. https://doi.org/10.1007/s10964-020-01387-8

Jerónimo, R., Volpert, H. I., & Bartholow, B. D. (2017). Event-related potentials reveal early attention bias for negative, unexpected behavior. *Social Neuroscience, 12*(2), 232-236. https://doi.org/10.1080/17470919.2016.1144646

Johnson, S. P., Alt, N. P., Biosah, C., Dong, M., Goodale, B. M., Senturk, D., & Johnson, K. L. (2021). Development of infants' representation of female and male faces. *Vision Research*, *184*, 1-7. https://doi.org/10.1016/j.visres.2021.02.005

Jirout, J. J., & Newcombe, N. S. (2015). Building blocks for developing spatial skills: Evidence from a large, representative U.S. sample. *Psychological Science*, *26*(3), 302-310. https://doi.org/10.1177/0956797614563338

K

Kane, E. W. (2006). "No way my boys are going to be like that!" Parents' responses to children's gender nonconformity. *Gender & Society, 20*(2), 149-176. https://doi.org/10.1177/0891243205284276

Kiff, C. J., Lengua, L. J., & Zalewski, M. (2011). Nature and nurturing: Parenting in the context of child temperament. *Clinical Child and Family Psychology Review*, *14*(3), 251. https://doi.org/10.1007/s10567-011-0093-4

Kim, H.-J., Arnold, D. H., Fisher, P. H., & Zeljo, A. (2005). Parenting and preschoolers' symptoms as a function of child gender and SES. *Child & Family Behavior Therapy*, *27*(2), 23-41. https://doi.org/10.1300/J019v27n02_03

Klem, G., Luders, H. O., Jasperf, H., & Elger, C. (1999). Section 1. EEG (Technical Standards and Glossary)-1.1. The ten-twenty electrode system of the International Federation. *Electroencephalography and Clinical Neurophysiology-Supplements only*(52), 3-6.

Knutson, K. M., Mah, L., Manly, C. F., & Grafman, J. (2007). Neural correlates of automatic beliefs about gender and race. *Human Brain Mapping, 28*(10), 915-930. https://doi.org/10.1002/hbm.20320

Koenig, A. M. (2018). Comparing prescriptive and descriptive gender stereotypes about children, adults, and the elderly. *Frontiers in Psychology, 9,* 1086. https://doi.org/10.3389/fpsyg.2018.01086

Kok, G., Gottlieb, N. H., Peters, G.-J. Y., Mullen, P. D., Parcel, G. S., Ruiter, R. A. C., Fernández, M. E., Markham, C., & Bartholomew, L. K. (2016). A taxonomy of behaviour change methods: An intervention mapping approach. *Health Psychology Review, 10*(3), 297-312. https://doi.org/10.1080/17437199.2015.1077155

Kollmayer, M., Schober, B., & Spiel, C. (2018). Gender stereotypes in education: Development, consequences, and interventions. *European Journal of Developmental Psychology, 15*(4), 361-377. https://doi.org/10.1080/17405629.2016.1193483

Kringelbach, M. L. (2005). The human orbitofrontal cortex: Linking reward to hedonic experience. *Nature Reviews Neuroscience, 6*(9), 691-702. https://doi.org/10.1038/nrn1747

Kringelbach, M. L., & Rolls, E. T. (2004). The functional neuroanatomy of the human orbitofrontal cortex: Evidence from neuroimaging and neuropsychology. *Progress in Neurobiology, 72*(5), 341-372. https://doi.org/10.1016/j.pneurobio.2004.03.006

Krombholz, A., Schaefer, F., & Boucsein, W. (2007). Modification of N170 by different emotional expression of schematic faces. *Biological Psychology*, *76*(3), 156-162. https://doi.org/10.1016/j.biopsycho.2007.07.004

Krueger, J., & Rothbart, M. (1988). Use of categorical and individuating information in making inferences about personality. *Journal of Personality and Social Psychology*, *55*(2), 187-195. https://doi.org/10.1037/0022-3514.55.2.187

Kuchirko, Y., Bennet, A., Halim, M. L., Costanzo, P., & Ruble, D. (2021). *The influence of siblings on ethnically diverse children's gender typing across early development*. American Psychological Association. https://doi.org/10.1037/dev0001173

Kuefner, D., De Heering, A., Jacques, C., Palmero-Soler, E., & Rossion, B. (2010). Early visually evoked electrophysiological responses over the human brain (P1, N170) show stable patterns of face-sensitivity from 4 years to adulthood. *Frontiers in Human Neuroscience*, *3*. https://doi.org/10.3389/neuro.09.067.2009

Kuvalanka, K. A., Allen, S. H., Munroe, C., Goldberg, A. E., & Weiner, J. L. (2018). The experiences of sexual minority mothers with trans* children. *Family Relations, 67*(1), 70-87. https://doi.org/10.1111/fare.12226

Kuvalanka, K. A., Weiner, J. L., Munroe, C., Goldberg, A. E., & Gardner, M. (2017). Trans and gender-nonconforming children and their caregivers: Gender presentations, peer relations, and well-being at baseline. *Journal of Family Psychology*, *31*, 889-899. https://doi.org/10.1037/fam0000338

L

Langmuir, M. (2020). I started the 'gender reveal party' trend. And I regret it. *The Guardian*. https://www.theguardian.com/lifeandstyle/2020/jun/29/jenna-karvunidis-i-started-gender-reveal-party-trend-regret

Langner, O., Dotsch, R., Bijlstra, G., Wigboldus, D. H. J., Hawk, S. T., & van Knippenberg, A. (2010). Presentation and validation of the Radboud Faces Database. *Cognition and Emotion*, *24*(8), 1377-1388. https://doi.org/10.1080/02699930903485076

Larrance, D. T., & Twentyman, C. T. (1983). Maternal attributions and child abuse. *Journal of Abnormal Psychology*, *92*, 449-457. https://doi.org/10.1037/0021-843X.92.4.449

Le, B. M., & Impett, E. A. (2016). The costs of suppressing negative emotions and amplifying positive emotions during parental caregiving. *Personality and Social Psychology Bulletin*, *42*(3), 323-336. https://doi.org/10.1177/0146167216629122

Leaper, C., & Farkas, T. (2015). The socialization of gender during childhood and adolescence. In *Handbook of socialization: Theory and research, 2nd ed*. (pp. 541-565). The Guilford Press.

Leuthold, H., Filik, R., Murphy, K., & Mackenzie, I. G. (2011). The on-line processing of socio-emotional information in prototypical scenarios: Inferences from brain potentials. *Social Cognitive and Affective Neuroscience*, *7*(4), 457-466. https://doi.org/10.1093/scan/nsr029

Li, T., Cardenas-Iniguez, C., Correll, J., & Cloutier, J. (2016). The impact of motivation on race-based impression formation. *Neuroimage, 124*, 1-7. https://doi.org/10.1016/j.neuroimage.2015.08.035

Li, R. Y. H., & Wong, W. I. (2016). Gender-typed play and social abilities in boys and girls: Are they related? *Sex Roles*, *74*(9), 399-410. https://doi.org/10.1007/s11199-016-0580-7

Lilford, R. J., Richardson, A., Stevens, A., Fitzpatrick, R., Edwards, S., Rock, F., & Hutton, J. (2001). Issues in methodological research: Perspectives from researchers and commissioners. *Health Technology Assessment*. https://doi.org/10.3310/hta5080

Lindsey, E. W., & Mize, J. (2001). Contextual differences in parent–child play: Implications for children's gender role development. *Sex Roles*, *44*(3), 155-176. https://doi.org/10.1023/A:1010950919451

Liu, C., Liu, Y., Iqbal, Z., Li, W., Lv, B., & Jiang, Z. (2017). Symmetrical and asymmetrical interactions between facial expressions and gender information in face perception. *Frontiers in Psychology, 8*(1383). https://doi.org/10.3389/fpsyg.2017.01383

Liu, Y., Huang, H., McGinnis-Deweese, M., Keil, A., & Ding, M. (2012). Neural substrate of the late positive potential in emotional processing. *The Journal of Neuroscience*, *32*(42), 14563. https://doi.org/10.1523/JNEUROSCI.3109-12.2012

LoBue, V., & Thrasher, C. (2015). The Child Affective Facial Expression (CAFE) set: Validity and reliability from untrained adults. *Frontiers in Psychology, 5*, 1532. https://doi.org/10.3389/fpsyg.2014.01532

Lorber, J., & Farrell, S. A. (1991). *The social construction of gender*. Sage Newbury Park, CA.

Luck, S. J. (2014). An introduction to the event-related potential technique. MIT press.

Luck, S. J., Woodman, G. F., & Vogel, E. K. (2000). Event-related potential studies of attention. *Trends in Cognitive Sciences, 4*(11), 432-440. https://doi.org/10.1016/S1364-6613(00)01545-X

Luyster, R. J., Powell, C., Tager-Flusberg, H., & Nelson, C. A. (2014). Neural measures of social attention across the first years of life: Characterizing typical development and markers of autism risk. *Developmental Cognitive Neuroscience*, *8*, 131-143. https://doi.org/10.1016/j.dcn.2013.09.006

Lytton, H., & Romney, D. M. (1991). Parents' differential socialization of boys and girls: A meta-analysis. *Psychological Bulletin*, *109*(2), 267. https://doi.org/10.1037/0033-2909.109.2.267

M

Maas, C. J., & Hox, J. J. (2004). The influence of violations of assumptions on multilevel parameter estimates and their standard errors. *Computational Statistics & Data Analysis, 46*(3), 427-440. https://doi.org/10.1016/j.csda.2003.08.006

Maccoby, E. E. (1998). *The two sexes: Growing up apart, coming together* (Vol. 4). Harvard University Press.

MacPhee, D., & Prendergast, S. (2019). Room for improvement: Girls' and boys' home environments are still gendered. *Sex Roles*, *80*(5-6), 332-346. https://doi.org/10.1007/s11199-018-0936-2

Mars, R. B., Debener, S., Gladwin, T. E., Harrison, L. M., Haggard, P., Rothwell, J. C., & Bestmann, S. (2008). Trial-by-trial fluctuations in the event-related electroencephalogram reflect dynamic changes in the degree of surprise. *The Journal of Neuroscience*, *28*(47), 12539. https://doi.org/10.1523/JNEUROSCI.2925-08.2008

Martin, C. L. (1995). Stereotypes about children with traditional and nontraditional gender roles. *Sex Roles, 33*(11-12), 727-751. https://doi.org/10.1007/bf01544776

Martin, C. L., Andrews, N. C. Z., England, Dawn E., Zosuls, K., & Ruble, D. N. (2017). A dual identity approach for conceptualizing and measuring children's gender identity. *Child Development*, *88*(1), 167-182. https://doi.org/10.1111/cdev.12568

Martin, C. L., Fabes, R. A., Hanish, L. D., Gaertner, B., Miller, C. F., Foster, S., & Updegraff, K. A. (2017). Using an intergroup contact approach to improve gender relationships. In *The Wiley handbook of group processes in children and adolescents* (pp. 435-454). https://doi.org/10.1002/9781118773123.ch21

Martin, C. L., & Halverson, C. F. (1981). A schematic processing model of sex typing and stereotyping in children. *Child Development,* 1119-1134. https://doi.org/10.2307/1129498

Martin, J. L., & Ross, H. S. (2005). Sibling aggression: Sex differences and parents' reactions. *International Journal of Behavioral Development*, 29(2), 129-138. https://doi.org/10.1080/01650250444000469

Mascaro, J. S., Rentscher, K. E., Hackett, P. D., Mehl, M. R., & Rilling, J. K. (2017). Child gender influences paternal behavior, language, and brain function. *Behavioral Neuroscience, 131*(3), 262. https://doi.org/10.1037/bne0000199

Matuschek, H., Kliegl, R., Vasishth, S., Baayen, H., & Bates, D. (2017). Balancing type I error and power in linear mixed models. *Journal of Memory and Language*, *94*, 305-315. https://doi.org/10.1016/j.jml.2017.01.001

Maupin, A. N., Hayes, N. J., Mayes, L. C., & Rutherford, H. J. V. (2015). The application of electroencephalography to investigate the neural bases of parenting: A review. *Parenting, 15*(1), 9-23. https://doi.org/10.1080/15295192.2015.992735

McClure, E. B. (2000). A meta-analytic review of sex differences in facial expression processing and their development in infants, children, and adolescents. *Psychological Bulletin*, *126*(3), 424-453. https://doi.org/10.1037/0033-2909.126.3.424

McGuire, J. K., Kuvalanka, K. A., Catalpa, J. M., & Toomey, R. B. (2016). Transfamily theory: How the presence of trans* family members informs gender development in families. *Journal of Family Theory & Review*, *8*(1), 60-73. https://doi.org/10.1111/jftr.12125

McHale, S. M., Crouter, A. C., & Tucker, C. J. (1999). Family context and gender role socialization in middle childhood: Comparing girls to boys and sisters to brothers. *Child Development, 70*(4), 990-1004. https://doi.org/10.1111/1467-8624.00072

McHale, S. M., Crouter, A. C., & Whiteman, S. D. (2003). The family contexts of gender development in childhood and adolescence. *Social Development, 12*(1), 125-148. https://doi.org/10.1111/1467-9507.00225

McHale, S. M., Updegraff, K. A., Jackson-Newsom, J., Tucker, C. J., & Crouter, A. C. (2000). When does parents' differential treatment have negative implications for siblings? *Social Development*, *9*(2), 149-172. https://doi.org/10.1111/1467-9507.00117

McHale, S. M., Updegraff, K. A., Shanahan, L., Crouter, A. C., & Killoren, S. E. (2005). Siblings' differential treatment in Mexican American families. *Journal of Marriage and Family, 67*(5), 1259-1274. https://doi.org/10.1111/j.1741-3737.2005.00215.x

Melinder, A. M. D., Konijnenberg, C., Hermansen, T., Daum, M. M., & Gredebäck, G. (2015). The developmental trajectory of pointing perception in the first year of life. *Experimental Brain Research*, *233*(2), 641-647. https://doi.org/10.1007/s00221-014-4143-2

Mende-Siedlecki, P. (2018). Changing our minds: The neural bases of dynamic impression updating. *Current Opinion in Psychology*, *24*, 72-76. https://doi.org/10.1016/j.copsyc.2018.08.007

Menon, M., & Hannah-Fisher, K. (2019). Felt gender typicality and psychosocial adjustment in Indian early adolescents. *International Journal of Behavioral Development*, *43*, 334-341. https://doi.org/10.1177/0165025418820669

Mesman, J., & Groeneveld, M. G. (2018). Gendered parenting in early childhood: Subtle but unmistakable if you know where to look. *Child Development Perspectives, 12*(1), 22-27. https://doi.org/10.1111/cdep.12250

Meyer, M., & Gelman, S. A. (2016). Gender essentialism in children and parents: Implications for the development of gender stereotyping and gender-typed preferences. *Sex Roles, 75*(9), 409-421. https://doi.org/10.1007/s11199-016-0646-6

Mitchell, J. P. (2008). Contributions of functional neuroimaging to the study of social cognition. *Current Directions in Psychological Science, 17*(2), 142-146. https://doi.org/10.1111/j.1467-8721.2008.00564.x

Montemayor, R., & Ranganathan, C. (2012). Asian-Indian parents' attributions about the causes of child behavior: A replication and extension with parents from Chennai, India. *The Journal of Genetic Psychology*, *173*(4), 374-392. https://doi.org/10.1080/00221325.2011.614649

Morawska, A. (2020). The effects of gendered parenting on child development outcomes: A systematic review. *Clinical Child and Family Psychology Review*, 1-24. https://doi.org/10.1007/s10567-020-00321-5

Morrongiello, B. A., & Dawber, T. (2000). Mothers' responses to sons and daughters engaging in injury-risk behaviors on a playground: Implications for sex differences in injury rates. *Journal of Experimental Child Psychology, 76*(2), 89-103. https://doi.org/10.1006/jecp.2000.2572

Morrongiello, B. A., & Hogg, K. (2004). Mothers' reactions to children misbehaving in ways that can lead to injury: Implications for gender differences in children's risk taking and injuries. *Sex Roles, 50*(1), 103-118. https://doi.org/10.1023/B:SERS.0000011076.43831.a6

Morrongiello, B. A., Klemencic, N., & Corbett, M. (2008). Interactions between child behavior patterns and parent supervision: Implications for children's risk of unintentional injury. *Child Development, 79*(3), 627-638. https://doi.org/10.1111/j.1467-8624.2008.01147.x

Morrongiello, B. A., & Rennie, H. (1998). Why do boys engage in more risk taking than girls? The role of attributions, beliefs, and risk appraisals. *Journal of Pediatric Psychology, 23*(1), 33-43. https://doi.org/10.1093/jpepsy/23.1.33

Morrongiello, B. A., Zdzieborski, D., & Normand, J. (2010). Understanding gender differences in children's risk taking and injury: A comparison of mothers' and fathers' reactions to sons and daughters misbehaving in ways that lead to injury. *Journal of Applied Developmental Psychology, 31*(4), 322-329. https://doi.org/10.1016/j.appdev.2010.05.004

Moulson, M. C., Westerlund, A., Fox, N. A., Zeanah, C. H., & Nelson, C. A. (2009). The effects of early experience on face recognition: An event-related potential study of institutionalized children in Romania. *Child Development*, *80*(4), 1039-1056. https://doi.org/10.1111/j.1467-8624.2009.01315.x

Munsters, N. M., van Ravenswaaij, H., van den Boomen, C., & Kemner, C. (2019). Test-retest reliability of infant event related potentials evoked by faces. *Neuropsychologia*, *126*, 20-26. https://doi.org/10.1016/j.neuropsychologia.2017.03.030

N

Novitskiy, N., Ramautar, J. R., Vanderperren, K., De Vos, M., Mennes, M., Mijovic, B., Vanrumste, B., Stiers, P., Van den Bergh, B., Lagae, L., Sunaert, S., Van Huffel, S., & Wagemans, J. (2011). The bold correlates of the visual P1 and N1 in single-trial analysis of simultaneous EEG-fMRI recordings during a spatial detection task. *Neuroimage*, *54*(2), 824-835. https://doi.org/10.1016/j.neuroimage.2010.09.041

O

O'Doherty, J., Winston, J., Critchley, H., Perrett, D., Burt, D. M., & Dolan, R. J. (2003). Beauty in a smile: The role of medial orbitofrontal cortex in facial attractiveness. *Neuropsychologia, 41*(2), 147-155. https://doi.org/10.1016/S0028-3932(02)00145-8

Olson, I. R., McCoy, D., Klobusicky, E., & Ross, L. A. (2013). Social cognition and the anterior temporal lobes: A review and theoretical framework. *Social Cognitive and Affective Neuroscience,* 8(2), 123-133. https://doi.org/10.1093/scan/nss119

Onland-Moret, N. C., Buizer-Voskamp, J. E., Albers, M. E. W. A., Brouwer, R. M., Buimer, E. E. L., Hessels, R. S., de Heus, R., Huijding, J., Junge, C. M. M., Mandl, R. C. W., Pas, P., Vink, M., van der Wal, J. J. M., Hulshoff Pol, H. E., & Kemner, C. (2020). The YOUth study: Rationale, design, and study procedures. *Developmental Cognitive Neuroscience*, *46*, 100868. https://doi.org/10.1016/j.dcn.2020.100868

Osterhout, L., Bersick, M., & McLaughlin, J. (1997). Brain potentials reflect violations of gender stereotypes. *Memory & Cognition, 25*(3), 273-285. https://doi.org/10.3758/BF03211283

P

Pacilli, M. G., Pagliaro, S., Taurino, A., Spaccatini, F., Giovannelli, I., Massaro, G., & Caporale, F. (2017). Impact of gender essentialism on heterosexuals' negative attitudes toward same-sex parenting. *Psicologia Sociale*, *12*(3), 317-334. https://doi.org/10.1482/87888

Parent, J., McKee, L. G., & Forehand, R. (2016). Seesaw discipline: The interactive effect of harsh and lax discipline on youth psychological adjustment. *Journal of Child and Family Studies*, *25*(2), 396-406. https://doi.org/10.1007/s10826-015-0244-1

Parke, R. D. (2017). Family psychology: Past and future reflections on the field. *Journal of Family Psychology, 31*(3), 257-260. https://doi.org/10.1037/fam0000318

Peykarjou, S., Westerlund[2], A., Cassia, V. M., Kuefner, D., & Nelson, C. A. (2013). The neural correlates of processing newborn and adult faces in 3-year-old children. *Developmental Science*, *16*(6), 905-914. https://doi.org/10.1111/desc.12063

Pfeifer, J. H., & Allen, N. B. (2021). Puberty initiates cascading relationships between neurodevelopmental, social, and internalizing processes across adolescence. *Biological Psychiatry*, *89*(2), 99-108. https://doi.org/10.1016/j.biopsych.2020.09.002

Pilcher, J. (2017). Names and "doing gender": How forenames and surnames contribute to gender identities, difference, and inequalities. *Sex Roles*, *77*(11), 812-822. https://doi.org/10.1007/s11199-017-0805-4

Pinho, M., & Gaunt, R. (2021). Biological essentialism, gender ideologies, and the division of housework and childcare: Comparing male carer/female breadwinner and traditional families. *Journal of Social Psychology*, 1-17. https://doi.org/10.1080/00224545.2021.1983508

Plant, E. A., & Devine, P. G. (1998). Internal and external motivation to respond without prejudice. *Journal of Personality and Social Psychology, 75*(3), 811. https://doi.org/10.1037/0022-3514.75.3.811

Plant, E. A., Hyde, J. S., Keltner, D., & Devine, P. G. (2000). The gender stereotyping of emotions. *Psychology of Women Quarterly*, *24*(1), 81-92. https://doi.org/10.1111/j.1471-6402.2000.tb01024.x

Polich, J. (2007). Updating P300: An integrative theory of P3a and P3b. *Clinical Neurophysiology, 118*(10), 2128-2148. https://doi.org/10.1016/j.clinph.2007.04.019

Pomerleau, A., Bolduc, D., Malcuit, G., & Cossette, L. (1990). Pink or blue: Environmental gender stereotypes in the first two years of life. *Sex Roles*, *22*(5-6), 359-367. https://doi.org/10.1007/BF00288339

Portengen, C. M., Huffmeijer, R., van Baar, A. L., & Endendijk, J. J. (2022). Measuring the neural correlates of the violation of social expectations: A comparison of two experimental tasks. *Social Neuroscience*, *17*(1), 58-72. https://doi.org/10.1080/17470919.2022.2032327

Portengen, C. M., van Baar, A. L., & Endendijk, J. J. (2023). A neurocognitive approach to studying processes underlying parents' gender socialization. *Frontiers in Psychology*, *13*. https://doi.org/10.3389/fpsyg.2022.1054886

Porter, C. L., Evans-Stout, C. A., Reschke, P. J., Nelson, L. J., & Hyde, D. C. (2021). Associations between brain and behavioral processing of facial expressions of emotion and sensory reactivity in young children. *Developmental Science*, *24*(6), e13134. https://doi.org/10.1111/desc.13134

Potter, A., Dube, S., Allgaier, N., Loso, H., Ivanova, M., Barrios, L. C., Bookheimer, S., Chaarani, B., Dumas, J., Feldstein-Ewing, S., Freedman, E. G., Garavan, H., Hoffman, E., McGlade, E., Robin, L., & Johns, M. M. (2021). Early adolescent gender diversity and mental health in the Adolescent Brain Cognitive Development study. *Journal of Child Psychology and Psychiatry*, *62*(2), 171-179. https://doi.org/10.1111/jcpp.13248

Poulin-Dubois, D., Serbin, L. A., Eichstedt, J. A., Sen, M. G., & Beissel, C. F. (2002). Men don't put on make-up: Toddlers' knowledge of the gender stereotyping of household activities. *Social Development*, *11*(2), 166-181. https://doi.org/10.1111/1467-9507.00193

Powlishta, K. K. (2000). The effect of target age on the activation of gender stereotypes. *Sex Roles, 42*(3), 271-282. https://doi.org/10.1023/A:1007095307977

Proverbio, A. M., Alberio, A., & De Benedetto, F. (2018). Neural correlates of automatic beliefs about gender stereotypes: Males are more prejudicial. *Brain & Language, 186*, 8-16. https://doi.org/10.1016/j.bandl.2018.08.006

Proverbio, A. M., Orlandi, A., & Bianchi, E. (2017). Electrophysiological markers of prejudice related to sexual gender. *Neuroscience, 358*, 1-12. https://doi.org/10.1016/j.neuroscience.2017.06.028

Pruden, S. M., & Levine, S. C. (2017). Parents' spatial language mediates a sex difference in preschoolers' spatial-language use. *Psychological Science, 28*(11), 1583-1596. https://doi.org/10.1177/0956797617711968

Q

Quadflieg, S., Flannigan, N., Waiter, G. D., Rossion, B., Wig, G. S., Turk, D. J., & Macrae, C. N. (2011). Stereotype-based modulation of person perception. *Neuroimage, 57*(2), 549-557. https://doi.org/10.1016/j.neuroimage.2011.05.004

Quinn, K. A., Mason, M. F., & Macrae, C. N. (2009). Familiarity and person construal: Individuating knowledge moderates the automaticity of category activation. *European Journal of Social Psychology*, *39*(5), 852-861. https://doi.org/10.1002/ejsp.596

Quinn, P. C., Lee, K., & Pascalis, O. (2019). Face processing in infancy and beyond: The case of social categories. *Annual Review of Psychology*, *70*(1), 165-189. https://doi.org/10.1146/annurev-psych-010418-102753

Quinn, P. C., Uttley, L., Lee, K., Gibson, A., Smith, M., Slater, A. M., & Pascalis, O. (2008). Infant preference for female faces occurs for same- but not other-race faces. *Journal of Neuropsychology*, *2*(1), 15-26. https://doi.org/10.1348/174866407X231029

Quinn, P. C., Yahr, J., Kuhn, A., Slater, A. M., & Pascalis, O. (2002). Representation of the gender of human faces by infants: A preference for female. *Perception*, *31*(9), 1109-1121. https://doi.org/10.1068/p3331

R

R Core Team. (2013). R: A language and environment for statistical computing.

Raffaelli, M., & Ontai, L. L. (2004). Gender socialization in Latino/a families: Results from two retrospective studies. *Sex Roles, 50*(5), 287-299. https://doi.org/10.1023/B:SERS.0000018886.58945.06

Rahilly, E. P. (2015). The gender binary meets the gender-variant child: Parents' negotiations with childhood gender variance. *Gender & Society*, *29*(3), 338-361. https://doi.org/10.1177/0891243214563069

Reyna, C. (2000). Lazy, dumb, or industrious: When stereotypes convey attribution information in the classroom. *Educational Psychology Review, 12*(1), 85-110. https://doi.org/10.1023/A:1009037101170

Robinson, M. D., Johnson, J. T., & Shields, S. A. (1998). The gender heuristic and the database: Factors affecting the perception of gender-related differences in the experience and display of emotions. *Basic and Applied Social Psychology*, *20*(3), 206-219. https://doi.org/10.1207/s15324834basp2003_3

Rodríguez-Gómez, P., Romero-Ferreiro, V., Pozo, M. A., Hinojosa, J. A., & Moreno, E. M. (2020). Facing stereotypes: ERP responses to male and female faces after gender-stereotyped statements. *Social Cognitive and Affective Neuroscience, 15*(9), 928-940. https://doi.org/10.1093/scan/nsaa117

Rogers, A. A., Shawcroft, J., Stockdale, L. A., Coyne, S. M., & Fraser, A. M. (2023). Trajectories of parents' gendered play attitudes during early childhood and implications for children's gender development. *Child Development*. https://doi.org/10.1111/cdev.13989

Rolls, E. T., Cheng, W., & Feng, J. (2020). The orbitofrontal cortex: Reward, emotion and depression. *Brain Communications, 2*(2). https://doi.org/10.1093/braincomms/fcaa196

Root, A. K., & Rubin, K. H. (2010). Gender and parents' reactions to children's emotion during the preschool years. *New Directions for Child and Adolescent Development*, *2010*(128), 51-64. https://doi.org/10.1002/cd.268

Rubinstein, R. S., Jussim, L., & Stevens, S. T. (2018). Reliance on individuating information and stereotypes in implicit and explicit person perception. *Journal of Experimental Social Psychology*, *75*, 54-70. https://doi.org/10.1016/j.jesp.2017.11.009

Rudman, L. A., & Fairchild, K. (2004). Reactions to counterstereotypic behavior: The role of backlash in cultural stereotype maintenance. *Journal of Personality and Social Psychology*, *87*, 157-176. https://doi.org/10.1037/0022-3514.87.2.157

Rudman, L. A., & Goodwin, S. A. (2004). Gender differences in automatic in-group bias: Why do women like women more than men like men? *Journal of Personality and Social Psychology, 87*(4), 494. https://doi.org/10.1037/0022-3514.87.4.494

Rudman, L. A., Greenwald, A. G., Mellott, D. S., & Schwartz, J. L. (1999). Measuring the automatic components of prejudice: Flexibility and generality of the Implicit Association Test. *Social Cognition, 17*(4), 437-465. https://doi.org/10.1521/soco.1999.17.4.437

Rudman, L. A., Moss-Racusin, C. A., Glick, P., & Phelan, J. E. (2012a). Chapter four - reactions to vanguards: Advances in backlash theory. In P. Devine & A. Plant (Eds.), *Advances in experimental social psychology* (Vol. 45, pp. 167-227). Academic Press. https://doi.org/10.1016/B978-0-12-394286-9.00004-4

Rudman, L. A., Moss-Racusin, C. A., Phelan, J. E., & Nauts, S. (2012b). Status incongruity and backlash effects: Defending the gender hierarchy motivates prejudice against female leaders. *Journal of Experimental Social Psychology*, *48*(1), 165-179. https://doi.org/10.1016/j.jesp.2011.10.008

S

Sandberg, D. E., Ehrhardt, A. A., Ince, S. E., & Meyer-Bahlburg, H. F. (1991). Gender differences in children's and adolescents' career aspirations: A follow-up study. *Journal of Adolescent Research, 6*(3), 371-386. https://doi.org/10.1177/074355489163007

Sanders, W., Parent, J., Forehand, R., Sullivan, A. D. W., & Jones, D. J. (2016). Parental perceptions of technology and technology-focused parenting: Associations with youth screen time. *Journal of Applied Developmental Psychology*, *44*, 28-38. https://doi.org/10.1016/j.appdev.2016.02.005

Sandnabba, N. K., & Ahlberg, C. (1999). Parents' attitudes and expectations about children's cross-gender behavior. *Sex Roles, 40*(3-4), 249-263. https://doi.org/10.1023/A:1018851005631

Santos, A., Mier, D., Kirsch, P., & Meyer-Lindenberg, A. (2011). Evidence for a general face salience signal in human amygdala. *Neuroimage, 54*(4), 3111-3116. https://doi.org/10.1016/j.neuroimage.2010.11.024

Savage, M. (2022). The parents raising their children without gender. *BBC*. https://www.bbc.com/worklife/article/20220929-the-parents-raising-their-children-without-gender

Scheibling, C. (2022). "Why can't boys be #likeagirl?": Sticky essentialism and ambivalent (de)gendering in fathers' online accounts of children's gender and sexuality. *Sex Roles*, *86*(5), 366-378. https://doi.org/10.1007/s11199-022-01274-5

Schindler, S., Bruchmann, M., & Straube, T. (2020). Imagined veridicality of social feedback amplifies early and late brain responses. *Social Neuroscience, 15*(6), 678-687. 10.1080/17470919.2020.1857303

Schroeder, K. M., & Liben, L. S. (2021). Felt pressure to conform to cultural gender roles: Correlates and consequences. *Sex Roles, 84*(3), 125-138. https://doi.org/10.1007/s11199-020-01155-9

Sedikides, C., Campbell, W. K., Reeder, G. D., & Elliot, A. J. (1998). The self-serving bias in relational context. *Journal of Personality and Social Psychology*, *74*, 378-386. https://doi.org/10.1037/0022-3514.74.2.378

Serbin, L. A., Poulin-Dubois, D., Colburne, K. A., Sen, M. G., & Eichstedt, J. A. (2001). Gender stereotyping in infancy: Visual preferences for and knowledge of gender-stereotyped toys in the second year. *International Journal of Behavioral Development*, *25*(1), 7-15. https://doi.org/10.1080/01650250042000078

Serbin, L. A., Poulin-Dubois, D., & Eichstedt, J. A. (2002). Infants' responses to gender-inconsistent events. *Infancy*, *3*(4), 531-542. https://doi.org/10.1207/S15327078IN0304_07

Servin, A., & Bohlin, G. (1999). Do Swedish mothers have sex-stereotyped expectations and wishes regarding their own children? *Infant and Child Development*, *8*(4), 197-210. https://doi.org/10.1002/(SICI)1522-7219

Signorella, M. L., Bigler, R. S., & Liben, L. S. (1993). Developmental differences in children's gender schemata about others: A meta-analytic review. *Developmental Review*, *13*(2), 147-183. https://doi.org/10.1006/drev.1993.1007

Simon, R. W., & Nath, L. E. (2004). Gender and emotion in the United States: Do men and women differ in self-reports of feelings and expressive behavior? *American Journal of Sociology*, *109*(5), 1137-1176. https://doi.org/10.1086/382111

Siyanova-Chanturia, A., Pesciarelli, F., & Cacciari, C. (2012). The electrophysiological underpinnings of processing gender stereotypes in language. *PloS One, 7*(12), e48712. https://doi.org/10.1371/journal.pone.0048712

Skewes, L., Fine, C., & Haslam, N. (2018). Beyond Mars and Venus: The role of gender essentialism in support for gender inequality and backlash. *PloS One, 13*(7), e0200921. https://doi.org/10.1371/journal.pone.0200921

Skinner, O. D., & McHale, S. M. (2022). Family gender socialization in childhood and adolescence. In D. P. VanderLaan & W. I. Wong (Eds.), *Gender and sexuality development: Contemporary theory and research* (pp. 233-253). Springer International Publishing. https://doi.org/10.1007/978-3-030-84273-4_8

Slepian, M. L., Weisbuch, M., Adams Jr, R. B., & Ambady, N. (2011). Gender moderates the relationship between emotion and perceived gaze. *Emotion*, *11*(6), 1439-1444. https://doi.org/10.1037/a0026163

Smetana, J. G. (1989). Toddlers' social interactions in the context of moral and conventional transgressions in the home. *Developmental Psychology, 25*(4), 499. https://doi.org/10.1037/0012-1649.25.4.499

Smetana, J. G., Robinson, J., & Rote, W. M. (2015). Socialization in adolescence. In *Handbook of socialization: Theory and research, 2nd ed*. (pp. 60-84). The Guilford Press.

Smith, N. K., Cacioppo, J. T., Larsen, J. T., & Chartrand, T. L. (2003). May I have your attention, please: Electrocortical responses to positive and negative stimuli. *Neuropsychologia*, *41*(2), 171-183. https://doi.org/10.1016/S0028-3932(02)00147-1

Solebello, N., & Elliott, S. (2011). "We want them to be as heterosexual as possible": Fathers talk about their teen children's sexuality. *Gender & Society*, *25*(3), 293-315. https://doi.org/10.1177/0891243211403926

Spreckelmeyer, K. N., Kutas, M., Urbach, T. P., Altenmüller, E., & Münte, T. F. (2006). Combined perception of emotion in pictures and musical sounds. *Brain Research, 1070*(1), 160-170. https://doi.org/10.1016/j.brainres.2005.11.075

Stanley, D., Phelps, E., & Banaji, M. (2008). The neural basis of implicit attitudes. *Current Directions in Psychological Science, 17*(2), 164-170. https://doi.org/10.1111%2Fj.1467-8721.2008.00568.x

Steensma, T. D., Kreukels, B. P., de Vries, A. L., & Cohen-Kettenis, P. T. (2013). Gender identity development in adolescence. *Hormones and Behavior, 64*(2), 288-297. https://doi.org/10.1016/j.yhbeh.2013.02.020

Stewart, A. J., & McDermott, C. (2004). Gender in psychology. *Annual Review of Psychology, 55*(1), 519-544. https://doi.org/10.1146/annurev.psych.55.090902.141537

Stillman, P. E., Shen, X., & Ferguson, M. J. (2018). How mouse-tracking can advance social cognitive theory. *Trends in Cognitive Sciences, 22*(6), 531-543. https://doi.org/10.1016/j.tics.2018.03.012

Sugimura, T. (2006). How accurately do young children and adults discriminate the gender of natural faces? *Perceptual and Motor Skills*, *102*(3), 654-664. https://doi.org/10.2466/pms.102.3.654-664

Sullivan, J., Moss-Racusin, C., Lopez, M., & Williams, K. (2018). Backlash against gender stereotype-violating preschool children. *PloS One, 13*(4), e0195503. https://doi.org/10.1371/journal.pone.0195503

T

Tajfel, H., & Turner, J. (1986). The social identity theory of intergroup behavior. In S. Worchel & W. G. Austing (Eds.), *Psychology of intergroup relations.*

Taylor, M. C., & Hall, J. A. (1982). Psychological androgyny: Theories, methods, and conclusions. *Psychological Bulletin, 92*(2), 347. https://doi.org/10.1037/0033-2909.92.2.347

Taylor, M. J. (2002). Non-spatial attentional effects on P1. *Clinical Neurophysiology, 113*(12), 1903-1908. https://doi.org/10.1016/S1388-2457(02)00309-7

Taylor, P. J., & Marsh, J. E. (2017). E-Prime (Software). *The International Encyclopedia of Communication Research Methods*, 1-3. https://doi.org/10.1002/9781118901731.iecrm0085

Tenenbaum, H. R., & Leaper, C. (2002). Are parents' gender schemas related to their children's gender-related cognitions? A meta-analysis. *Developmental Psychology, 38*(4), 615. https://doi.org/10.1037/0012-1649.38.4.615

Todd, B. K., Fischer, R. A., Di Costa, S., Roestorf, A., Harbour, K., Hardiman, P., & Barry, J. A. (2018). Sex differences in children's toy preferences: A systematic review, meta-regression, and meta-analysis. *Infant and Child Development*, *27*(2), e2064. https://doi.org/10.1002/icd.2064

Todd, R. M., Lewis, M. D., Meusel, L.-A., & Zelazo, P. D. (2008). The time course of social-emotional processing in early childhood: ERP responses to facial affect and personal familiarity in a go-nogo task. *Neuropsychologia*, *46*(2), 595-613. https://doi.org/10.1016/j.neuropsychologia.2007.10.011

Treutler, C. M., & Epkins, C. C. (2003). Are discrepancies among child, mother, and father reports on children's behavior related to parents' psychological symptoms and aspects of parent–child relationships? *Journal of Abnormal Child Psychology, 31*(1), 13-27. https://doi.org/10.1023/A:1021765114434

Twenge, J. M. (2023). Generations: The real differences between Gen Z, millennials, Gen X, boomers, and silents—and what they mean for America's future. Simon and Schuster.

Twomey, D. M., Murphy, P. R., Kelly, S. P., & O'Connell, R. G. (2015). The classic P300 encodes a build-to-threshold decision variable. *European Journal of Neuroscience, 42*(1), 1636-1643. https://doi.org/10.1111/ejn.12936

U

Updegraff, K. A., McHale, S. M., & Crouter, A. C. (1996). Gender roles in marriage: What do they mean for girls' and boys' school achievement? *Journal of Youth and Adolescence, 25*(1), 73-88. https://doi.org/10.1007/BF01537381

V

Van Caenegem, E., Wierckx, K., Elaut, E., Buysse, A., Dewaele, A., Van Nieuwerburgh, F., De Cuypere, G., & T'Sjoen, G. (2015). Prevalence of gender nonconformity in Flanders, Belgium. *Archives of Sexual Behavior*, *44*(5), 1281-1287. https://doi.org/10.1007/s10508-014-0452-6

van der Pol, L. D., Groeneveld, M. G., Endendijk, J. J., van Berkel, S. R., Hallers-Haalboom, E. T., Bakermans-Kranenburg, M. J., & Mesman, J. (2016). Associations between fathers' and mothers' psychopathology symptoms, parental emotion socialization, and preschoolers' social-emotional development. *Journal of Child and Family Studies*, *25*(11), 3367-3380. https://doi.org/10.1007/s10826-016-0490-x

van der Pol, L. D., Groeneveld, M. G., van Berkel, S. R., Endendijk, J. J., Hallers-Haalboom, E. T., Bakermans-Kranenburg, M. J., & Mesman, J. (2015). Fathers' and mothers' emotion talk with their girls and boys from toddlerhood to preschool age. *Emotion, 15*(6), 854. https://doi.org/10.1037/emo0000085

van der Velde, B., & Junge, C. (2020). Limiting data loss in infant EEG: Putting hunches to the test. *Developmental Cognitive Neuroscience*, *45*, 100809. https://doi.org/10.1016/j.dcn.2020.100809

Vandello, J. A., & Bosson, J. K. (2013). Hard won and easily lost: A review and synthesis of theory and research on precarious manhood. *Psychology of Men & Masculinity*, *14*(2), 101. https://doi.org/10.1037/a0029826

Vandello, J. A., Bosson, J. K., Cohen, D., Burnaford, R. M., & Weaver, J. R. (2008). Precarious manhood. *Journal of Personality and Social Psychology*, *95*(6), 1325-1339. https://doi.org/10.1037/a0012453

Vlamings, P. H. J. M., Jonkman, L. M., & Kemner, C. (2010). An eye for detail: An event-related potential study of the rapid processing of fearful facial expressions in children. *Child Development*, *81*(4), 1304-1319. https://doi.org/10.1111/j.1467-8624.2010.01470.x

Vogel, E. K., & Luck, S. J. (2000). The visual N1 component as an index of a discrimination process. *Psychophysiology, 37*(2), 190-203. https://doi.org/10.1111/1469-8986.3720190

Volpert-Esmond, H. I., Page-Gould, E., & Bartholow, B. D. (2021). Using multilevel models for the analysis of event-related potentials. *International Journal of Psychophysiology*, *162*, 145-156. https://doi.org/10.1016/j.ijpsycho.2021.02.006

W

Wang, M.-T., & Degol, J. L. (2017). Gender gap in science, technology, engineering, and mathematics (STEM): Current knowledge, implications for practice, policy, and future directions. *Educational Psychology Review*, *29*(1), 119-140. https://doi.org/10.1007/s10648-015-9355-x

Weinraub, M., Clemens, L. P., Sockloff, A., Ethridge, T., Gracely, E., & Myers, B. (1984). The development of sex role stereotypes in the third year: Relationships to gender labeling, gender identity, sex-types toy preference, and family characteristics. *Child Development*, 1493-1503. https://doi.org/10.2307/1130019

Weisgram, E. S. (2022). Gender, toys, and play: How gendered early experiences shape later development. In *Gender and sexuality development: Contemporary theory and research* (pp. 207-232). Springer.

Weisgram, E. S., & Bruun, S. T. (2018). Predictors of gender-typed toy purchases by prospective parents and mothers: The roles of childhood experiences and gender attitudes. *Sex Roles, 79*(5), 342-357. https://doi.org/10.1007/s11199-018-0928-2

Werheid, K., Alpay, G., Jentzsch, I., & Sommer, W. (2005). Priming emotional facial expressions as evidenced by event-related brain potentials. *International Journal of Psychophysiology*, *55*(2), 209-219. https://doi.org/10.1016/j.ijpsycho.2004.07.006

White, K. R., Crites, S. L., Jr, Taylor, J. H., & Corral, G. (2009). Wait, what? Assessing stereotype incongruities using the N400 ERP component. *Social Cognitive and Affective Neuroscience, 4*(2), 191-198. https://doi.org/10.1093/scan/nsp004

Wiesenfeld, A. R., & Klorman, R. (1978). The mother's psychophysiological reactions to contrasting affective expressions by her own and an unfamiliar infant. *Developmental Psychology*, *14*, 294-304. https://doi.org/10.1037/0012-1649.14.3.294

Wiesenfeld, A. R., Malatesta, C. Z., & Deloach, L. L. (1981). Differential parental response to familiar and unfamiliar infant distress signals. *Infant Behavior and Development*, *4*, 281-295. https://doi.org/10.1016/S0163-6383(81)80030-6

Williams, J. K., & Themanson, J. R. (2011). Neural correlates of the Implicit Association Test: Evidence for semantic and emotional processing. *Social Cognitive and Affective Neuroscience, 6*(4), 468-476. https://doi.org/10.1093/scan/nsq065

Wong, W. I., & Yeung, S. P. (2019). Early gender differences in spatial and social skills and their relations to play and parental socialization in children from hong kong. *Archives of Sexual Behavior*, *48*(5), 1589-1602. https://doi.org/10.1007/s10508-019-1415-8

Wood, W., & Eagly, A. H. (2012). Chapter two - biosocial construction of sex differences and similarities in behavior. In J. M. Olson & M. P. Zanna (Eds.), *Advances in experimental social psychology* (Vol. 46, pp. 55-123). Academic Press. https://doi.org/10.1016/B978-0-12-394281-4.00002-7

Wood, W., & Eagly, A. H. (2015). Two traditions of research on gender identity. *Sex Roles, 73*(11), 461-473. https://doi.org/10.1007/s11199-015-0480-2

X

Xiao, F., Zheng, Z., Wang, Y., Cui, J., & Chen, Y. (2015). Conflict monitoring and stimulus categorization processes involved in the prosocial attitude Implicit Association Test: Evidence from event-related potentials. *Social Neuroscience, 10*(4), 408-417. https://doi.org/10.1080/17470919.2014.1003598

Xie, W., Kumar, S., Kakon, S. H., Haque, R., Petri, W. A., & Nelson, C. A. (2019). Chronic inflammation is associated with neural responses to faces in Bangladeshi children. *Neuroimage*, *202*, 116110. https://doi.org/10.1016/j.neuroimage.2019.116110

Y

Yang, Y., White, K. R. G., Fan, X., Xu, Q., & Chen, Q.-W. (2020). Differences in explicit stereotype activation among social groups based on the stereotype content model: Behavioral and electrophysiological evidence in Chinese sample. *Brain Sciences, 10*(12), 1001. https://doi.org/10.3390/brainsci10121001

Yao, Z., & Wang, Z. (2014). Concreteness of positive word contributions to affective priming: An ERP study. *International Journal of Psychophysiology, 93*(3), 275-282. https://doi.org/10.1016/j.ijpsycho.2014.06.005

Yunger, J. L., Carver, P. R., & Perry, D. G. (2004). Does gender identity influence children's psychological well-being? *Developmental Psychology*, *40*, 572-582. https://doi.org/10.1037/0012-1649.40.4.572

Z

Zahn-Waxler, C., Shirtcliff, E. A., & Marceau, K. (2008). Disorders of childhood and adolescence: Gender and psychopathology. *Annual Review of Clinical Psychology*, *4*(1), 275-303. https://doi.org/10.1146/annurev.clinpsy.3.022806.091358

Zhu, D., Chen, Y., Li, L., & Dunsmore, J. C. (2023). Family functioning, emotion socialization, and children's social competence: Gender-specific effects in Chinese families. *Journal of Child and Family Studies*, *32*(1), 257-271. https://doi.org/10.1007/s10826-022-02480-1

Zosuls, K. M., Ruble, D. N., Tamis-LeMonda, C. S., Shrout, P. E., Bornstein, M. H., & Greulich, F. K. (2009). The acquisition of gender labels in infancy: Implications for gender-typed play. *Developmental Psychology*, *45*(3), 688. https://doi.org/10.1037/a0014053

Zucker, K. J. (2017). Epidemiology of gender dysphoria and transgender identity. *Sexual Health*, *14*(5), 404-411. https://doi.org/10.1071/SH17067

Zuckerman, M. (1979). Attribution of success and failure revisited, or: The motivational bias is alive and well in attribution theory. *Journal of Personality*, *47*(2), 245-287._https://doi.org/10.1111/j.1467-6494.1979.tb00202.x

Appendices

Appendix A. Chapter 3 supplementary materials

Data cleaning

For the IFT, 4 participants had 1 channel marked as bad. For 2 participants, 2 channels were excluded. 3 and 4 channels were marked 'bad' for one participant each. For the IAT, only one participant had two channels removed from the data. Six participants had 1 channel marked as 'bad' which were subsequently removed from the data. For the IFT, on average 2.2% of the 240 trials were discarded (range 0 – 10.4%). For the IAT, the average number of discarded trials was 0.6% (range 0 – 3.7%). In the IAT analyses, data from two participants were excluded due to excessive noise and artefacts in their data (significant noise in more than 25% of the trials on multiple channels).

Assumptions check

The assumption of non-linearity of residuals and homogeneity of variance were violated; however, multilevel models are relatively robust for violations of this assumption (Maas & Hox, 2004). QQ-plots confirmed that the standardized residuals for all models were normally distributed. Multicollinearity was avoided by including mean-centered predictors and dichotomous variables only.

Uncorrected N1 results

Toy

N1 amplitude was negatively associated with implicit gender stereotypes independent of stimulus type or congruence ($\beta = -0.400$, $t(25) = -2.571$, $p = 0.017$, $r = 0.457$). All other main effects and interactions were non-significant ($ps > 0.05$).

Behavior

A significant main effect was found for congruence ($\beta = -0.187$, $t(31) = -2.419$, $p = 0.022$, $r = 0.398$). Secondly, a significant interaction was found between stimulus type and congruence ($\beta = 0.199$, $t(25) = 2.126$, $p = 0.044$, $r = 0.391$). All other effects and interactions were non-significant (all p-values > 0.05).

Table S3.1. A list of internalizing and externalizing behaviors and whether they were rated as typically female (1) or typically male (5) (N = 55).

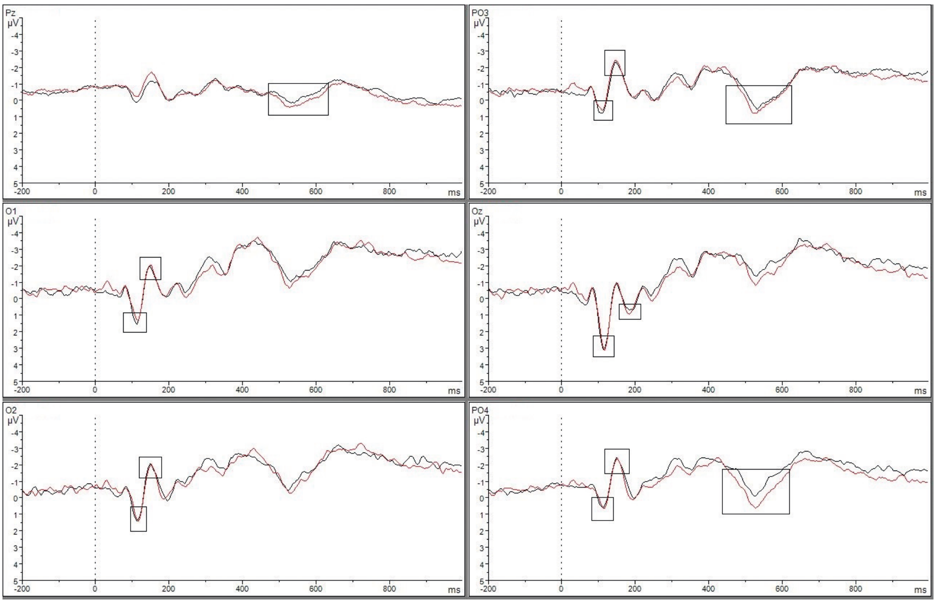
	M	*SD*	*t*-value(df)	*p*-value
Aggressive*	4.00	0.385	19.268 (54)	<.001
Biting	2.91	1,023	-0.659 (54)	.531
Excitable	2.78	0.712	-2.272 (54)	.027
Dependent*	2.53	0.716	-4.894 (54)	<.001
Shy*	2.42	0.658	-6.557 (54)	<.001
Attention-seeking	2.78	0.712	-2.272 (54)	.027
Sensitive*	2.47	0.716	-5.459 (54)	<.001
Unhappy*	2.75	0.552	-3.422 (54)	.001
Moping	2.35	0.645	-7.531 (54)	<.001
Indifferent	3.51	0.858	4.401 (54)	<.001
Bullying	3.25	0.775	2.436 (54)	.018
Selfish	3.18	0.669	2.015 (54)	.049
Cruel*	3.51	0.742	5.087 (54)	<.001
Depressed*	2.71	0.629	-3.431 (54)	.001
Inattentive*	3.67	0.579	8.615 (54)	<.001
Restless	3.65	0.645	7.531 (54)	<.001
Impatient	3.18	0.772	1.747 (54)	.086
Needy	2.58	0.567	-5.466 (54)	<.001
Sad*	2.42	0.534	-8.085 (54)	<.001
Jealous	2.39	0.656	-6.842 (53)	<.001
Disobedient*	3.53	0.742	5.272 (54)	<.001
Fighting*	4.29	0.658	14.560 (54)	<.001
Nosy	2.55	0.857	-3.935 (54)	<.001
Violent*	4.15	0.405	21.000 (54)	<.001
Kicking*	3.93	0.604	11.383 (54)	<.001
Noisy*	3.56	0.739	5.653 (54)	<.001
Fearful*	2.4	0.564	-7.884 (54)	<.001
Worried*	2.04	0.637	-11.215 (54)	<.001
Stubborn	3.18	0.669	2.015 (54)	.049

Table S3.1. *(continued)*

	M	*SD*	*t*-value(df)	*p*-value
Agitated*	3.64	0.825	5.723 (54)	<.001
Childish	3.55	0.835	4.845 (54)	<.001
Pouting	2.93	0.69	-.782 (54)	.438
Ashamed*	2.36	0.557	-8.480 (54)	<.001
Screaming	3.22	0.769	2.124 (53)	.038
Numb	3.65	0.615	7.891 (54)	<.001
Threatening*	3.87	0.546	11.850 (54)	<.001
Avoidant*	2.73	0.781	-2.591 (54)	.012
Petulant	2.87	0.474	-1.993 (54)	.051

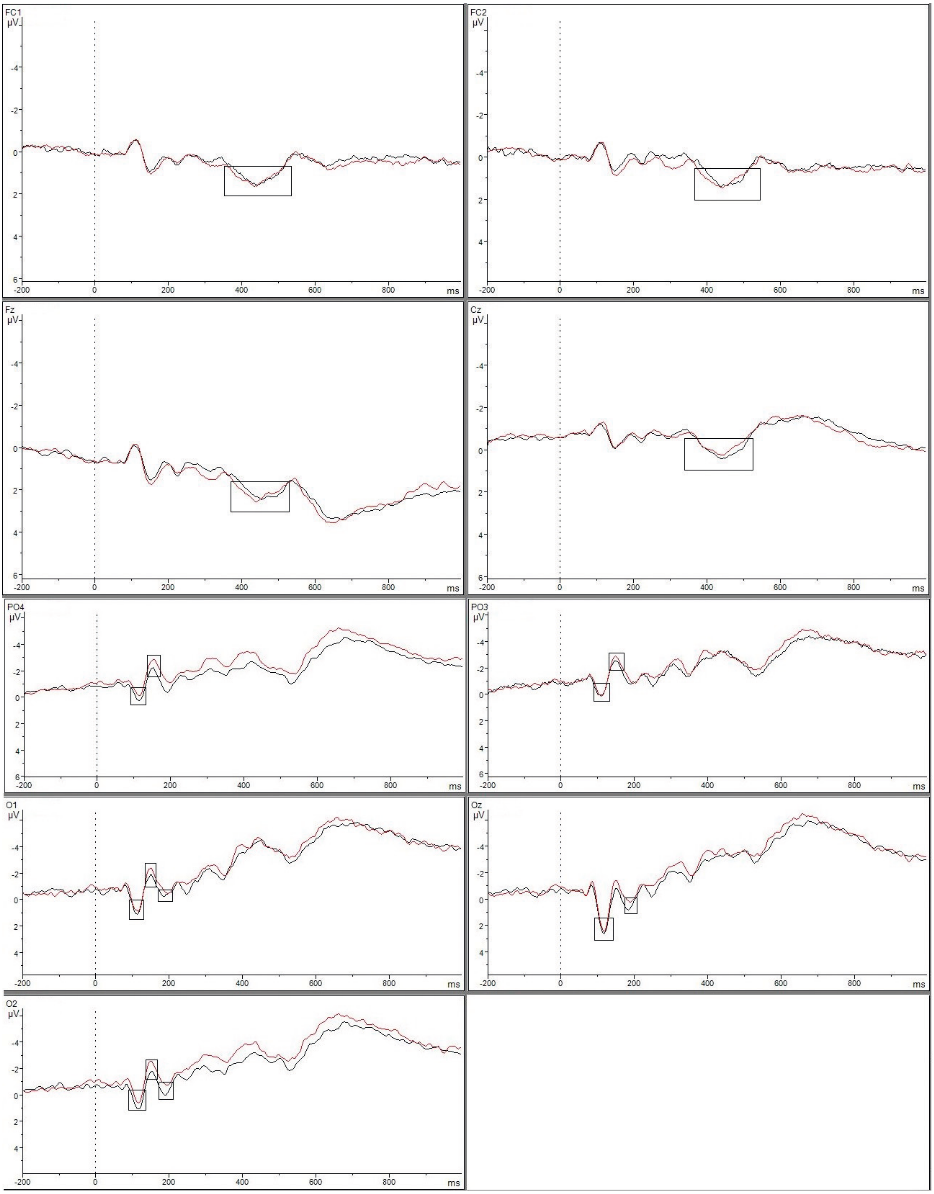
Note. Words were presented in Dutch. An asterisk indicates the words that were selected for the IFT and IAT task.

Figure S3.1. Grand average waveforms per electrodes as selected for the Impression Formation Task in the toy block.



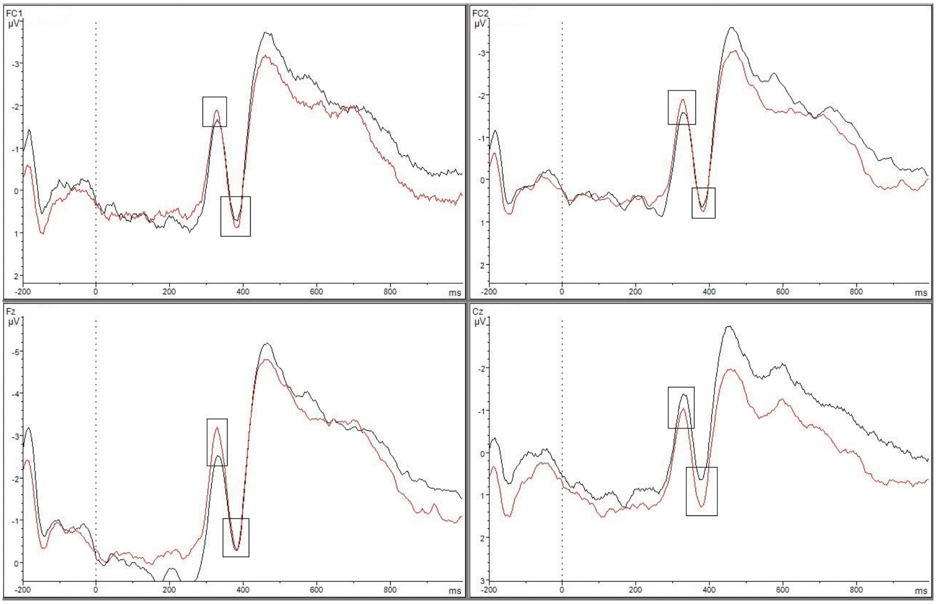
Note. The black lines represent congruent trials, the red lines represent incongruent trials

Figure S3.2. Grand average waveforms per electrodes as selected for the Impression Formation Task in the behavior block.



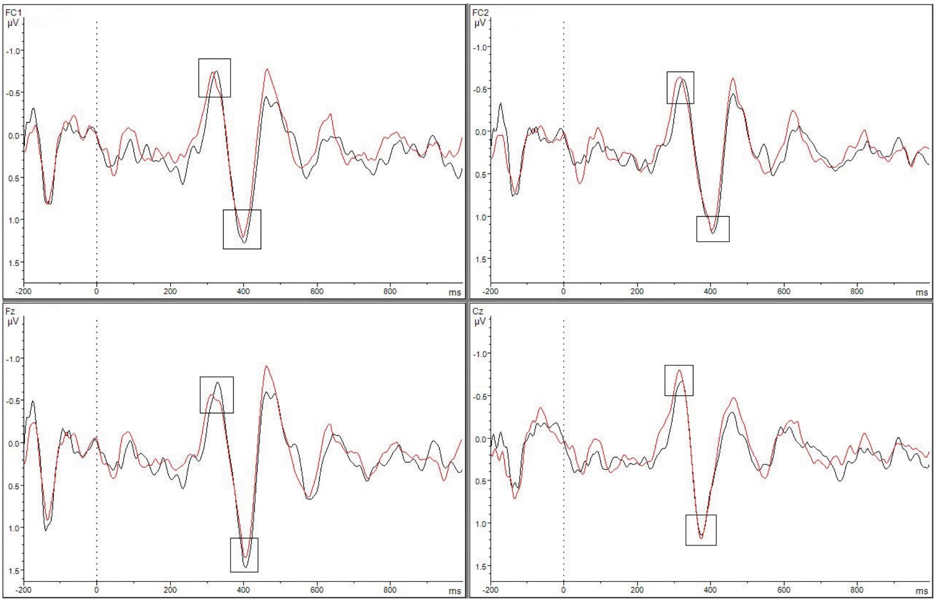
Note. The black lines represent congruent trials, the red lines represent incongruent trials

Figure S3.3. Grand average waveforms per electrodes as selected for the Implicit Association Test in the toy block.



Note. The black lines represent congruent trials, the red lines represent incongruent trials.

Figure S3.4. Grand average waveforms per electrodes as selected for the Implicit Association Test in the behavior block.



Note. The black lines represent congruent trials, the red lines represent incongruent trials

Figure S3.5. The effect of implicit gender stereotypes on P1 amplitudes during the behavior block of the Impression Formation Task, separate for congruent and incongruent trials.

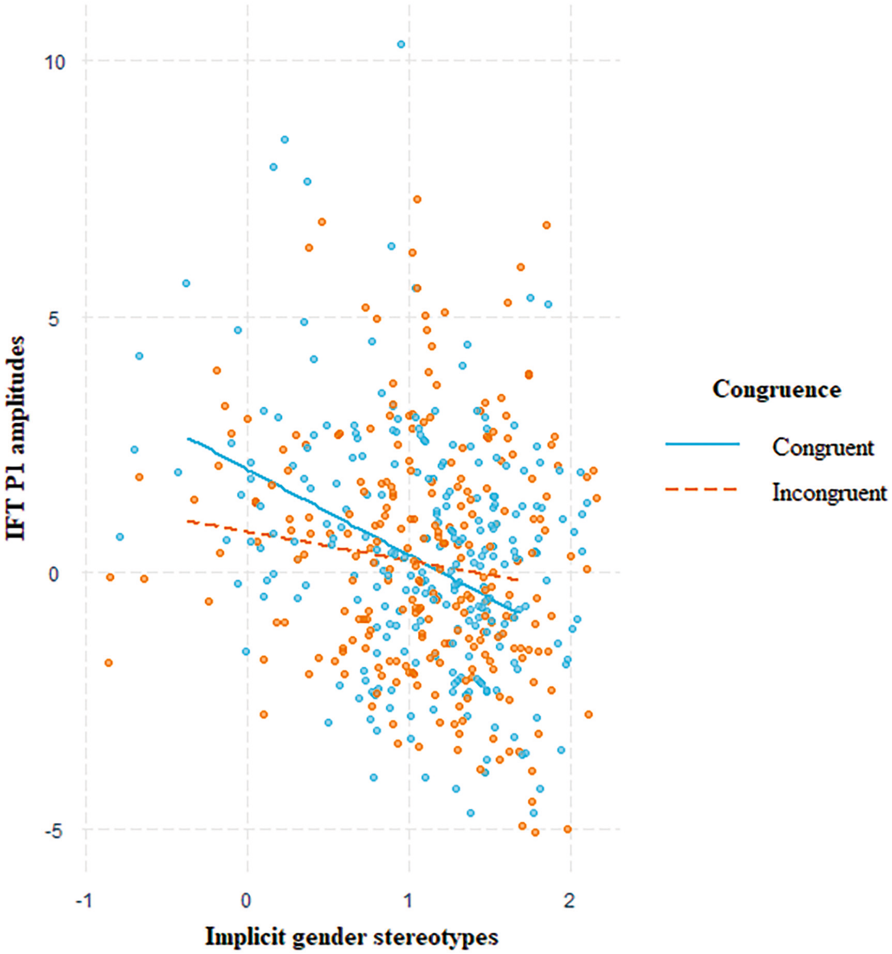


Figure S3.6. The effect of gendered attitudes about behavior on LPP amplitudes during the behavior block of the Impression Formation Task, separate for congruent and incongruent trials.

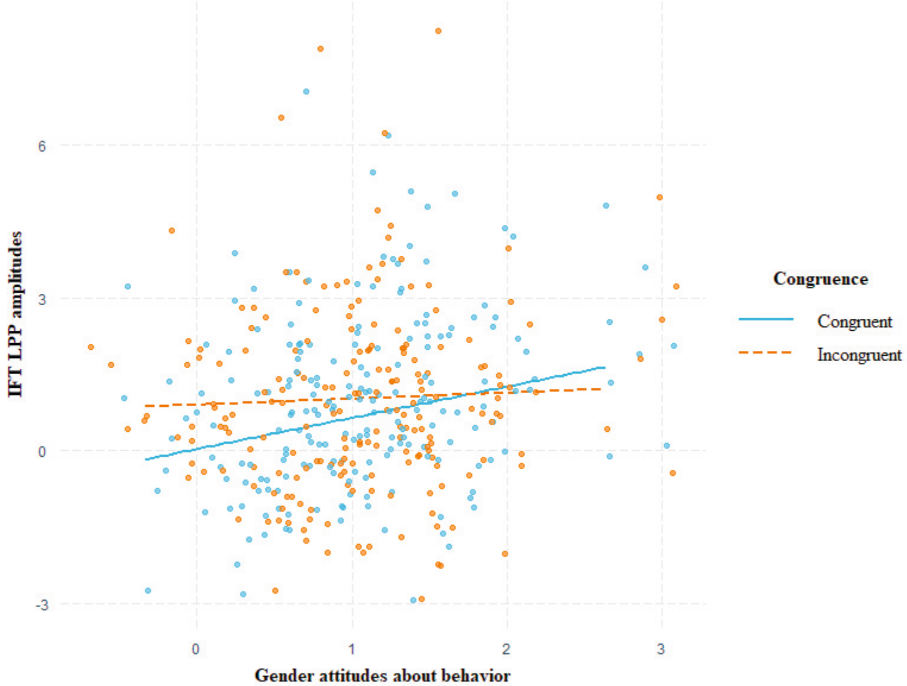
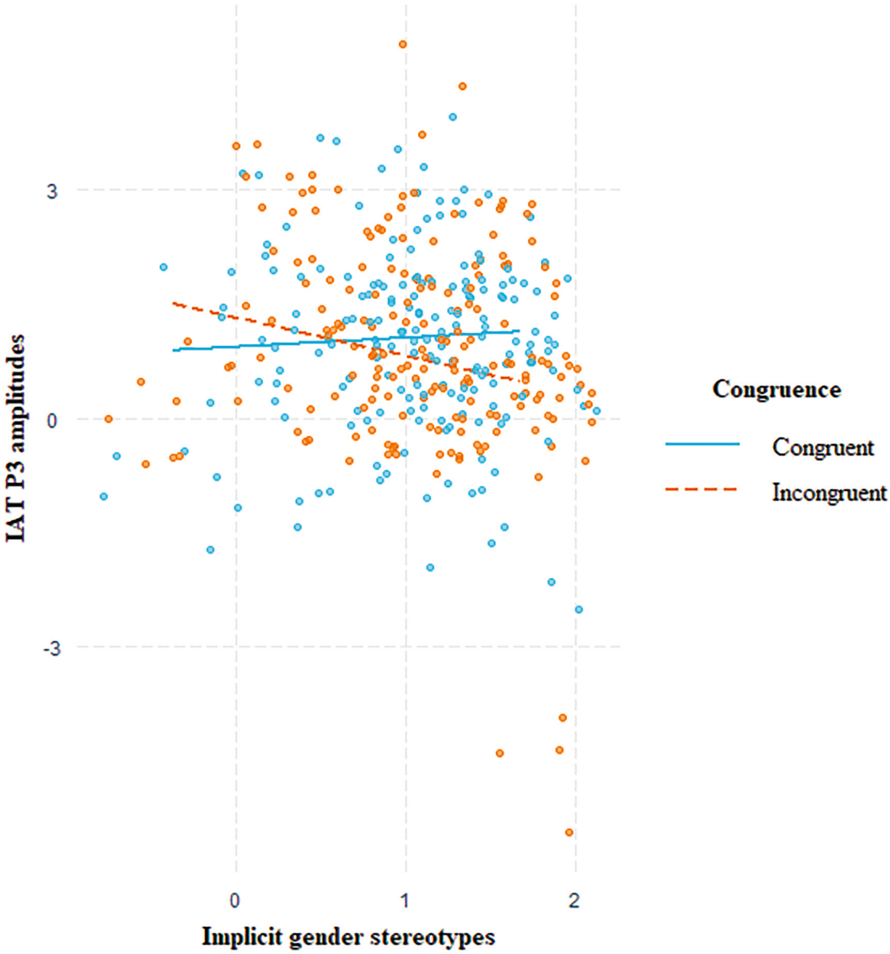


Figure S3.7. The effect of implicit gender stereotypes on P3 amplitudes during the congruent vs. incongruent behavior block of the Implicit Association Test.



Appendix B: Chapter 4 supplementary materials

Instructions parents photographs of own children

Parents were instructed to send in a picture of their participating son and daughter with a neutral facial expression. To ensure sufficient quality and similarity, parents were instructed to upload a picture of their children wearing neutral colors and with a white background, wearing neutral colors. Parents were sent an exemplar picture that was not selected for the Impression Formation Task to ensure parents knew what was expected of the photographs (see Figure S4.1). Pictures were visually checked by the first author CP, cropped in size, and brightness levels were adjusted to ensure that the luminance range was between 190 - 205. If the pictures were not of sufficient quality for the EEG task, parents were given more specific instructions about what needed to be adjusted (e.g., lighting, facial expression of the child, background) and requested to upload a new picture.

Supplementary results

The supplementary results consist of five parts. First, we describe the steps taken and models that were compared that led to the models that are described in the main paper. The second part of the supplementary results contain the findings from the toy block in which we found no main and interaction effects of congruence on ERP mean amplitudes. Third, since several of the findings regarding ERP mean amplitude differences during the behavior block described in the main paper are corrected for the preceding component, this section contains the uncorrected results. Fourth, since we were only interested in the congruence effects for the main paper, the fourth section describes the significant effects that were not related to congruence. Finally, we post-hoc examined the effects of congruence on N400 mean amplitudes during the toy block and behavior block. These results are described in the final Supplementary Results section.

Model selection procedures

For all models, a basic intercept model was plotted as the baseline model. First, main effects were added and compared with the intercept only model. As a second step, two-way-interactions were added and compared with the main effect model to examine model fits. If an interaction did not significantly improve the model fits, it was not added to the model. Third, three-way-interactions were added to examine if these would improve model fits. Again, if they would not improve model fits, they were omitted from the model. These steps were repeated separately for each model.

Model selection toy block

P1

Adding congruence, child gender and child type as main effects significantly improved model fit from the base model (*AIC* = 36127, $\chi^2(5) = 472.4$, $p < .001$). Adding parent gender or parents' gender attitudes about toys did not lead to an improvement of model fits ($p = .105$). Adding an interaction between congruence and child gender and congruence and child type additionally led to a significant improvement of the model (*AIC* = 36214, $\chi^2(9) = 774.8$, $p < .001$). Lastly, adding a three-way interaction between congruence, child gender, and child type significantly improved the model (*AIC* = 29734, $\chi^2(29)$, $p < .001$).

N1

Adding congruence, child gender, and child type to the model significantly improved model fits (*AIC* = 36971, $\chi^2(5) = 494.7$, $p < .001$). When adding the main effects of parents' gender attitudes about toys and parent gender, model fits did not significantly improve ($p = .061$). Adding an interaction between congruence and child gender led to convergence issues so this interaction was omitted from the model. Adding an interaction between congruence and child type significantly improved model fit (*AIC* = 34977, $\chi^2(8) = 2009.5$, $p < .001$). Further adding of interactions also led to convergence issues, so the final model included a main effect of congruence, child gender, and child type, and an interaction between the congruence and child type.

P2

Adding congruence, child gender, and child type to the model significantly improved model fits (*AIC* = 21885, $\chi^2(5) = 305.41$, $p < .001$). Adding the main effects of gender attitudes and parent gender did not significantly improve model fits ($p = .227$). Adding an interaction between congruence and child gender resulted in convergence issues so this interaction was omitted from the model. The interaction between congruence and child type did significantly improve model fit (*AIC* = 20578, $\chi^2(8) = 1323.3$, $p < .001$). Finally, the three-way interaction between congruence, child gender, child type led to a significant improvement of model fit (*AIC* = 18639, $\chi^2(29) = 1996.1$, $p < .001$).

P3

Adding the main effects of congruence, child gender, and child type to the basic model significantly improved the model fit (*AIC* = 17178, $\chi^2(5) = 212.1$, $p < .001$). Adding the main effects of parent gender or parents' gender attitudes about toys did not significantly improve model fits thus these variables were omitted from the model ($p = .596$). Adding the interaction between congruence and child gender and congruence and child type also significantly improved model fit (*AIC* = 16345, $\chi^2(9) = 850.59$, $p < .001$). Lastly, the three-way interaction between congruence, child gender, and child type also led to a significant improvement (*AIC* = 15548, $\chi^2(28) = 853.4$, $p < .001$).

Late positive potential

The main effects of congruence, child gender, and child type significantly improved model fits (*AIC* = 19457, $\chi^2(5) = 230.0$, $p < .001$). Adding the main effects of parent gender or parents' gender attitudes about toys did not significantly improve the model fit ($p = .316$). Moreover, the interactions between congruence and child gender and congruence and child type led to a significant improvement of the model fit (*AIC* = 18377, $\chi^2(9) = 1098.9$, $p < .001$). Lastly, adding the three-way interaction between congruence, child gender, and child type, also significantly improved model fit (*AIC* = 16964, $\chi^2(28) = 1468.9$, $p < .001$).

Model selection behavior block

P1

Adding congruence and the child variables (child gender, child type) significantly improved model fits compared to the intercept only model (*AIC* = 35646, $\chi^2(5) = 481.7$, $p < .001$). Adding parent gender and parents' gender attitudes as main effects additionally significantly improved model fits (*AIC* = 35641, $\chi^2(2) = 8.6$, $p = .014$). Adding the interactions between congruence and child gender and congruence and child type also significantly improved the predictive value of the model (*AIC* = 34885, $\chi^2(9) = 774.3$, $p < .001$). Adding the interactions between congruence and participant variables (parent gender, parents' gender attitudes about behavior) also significantly improved model fits (*AIC* = 34887, $\chi^2(11) = 776.2$, $p < .001$). Adding a three-way interaction between congruence, child gender, and child type significantly improved model fits (*AIC* = 29781, $\chi^2(29) = 5162.4$, $p < .001$). Adding three-way interactions between congruence, child gender/type and parent gender or parents' gender attitudes led to convergence issues and were omitted from the model. The final model thus included all main effects, two-way interactions between congruence and child gender/child type, and congruence and parent gender/parents' gender attitudes about behavior, as well as a three-way interaction between congruence, child gender, and child type.

N1

Adding main effects of congruence, child gender, and child type to the model significantly improved model fit compared to the intercept only model (*AIC* = 36973, $\chi^2(5) = 547.5$, $p < .001$). Moreover, adding the main effects of parent gender and parents' gender attitudes significantly improved model fits (*AIC* = 36966, $\chi^2(2) = 10.9$, $p = .004$). Regarding the two-way interactions, congruence and child gender/child type and congruence and parents' gender attitudes and parent gender significantly improved the model's fit (*AIC* = 36351, $\chi^2(11) = 637.0$, $p < .001$). Adding three-way interactions led to convergence issues, so these were omitted.

P2

Adding all main effects led to a significant improvement of the base model (child variables: *AIC 22120*, $\chi^2(5) = 348.9$, $p < .001$; parent variables: *AIC* = 22114, $\chi^2(2) = 9.7$, p -= .008). Adding interactions between congruence and child gender and child type also significantly improved the model fit (*AIC* = 20096, $\chi^2(20) = 2058.7$, $p < .001$), as did the interactions between congruence and parents' gender attitudes (*AIC* = 20087, $\chi^2(1) = 10.5$, $p < .001$). The interaction between congruence and parent gender led to convergence issues and was thus omitted. Finally, a three-way interaction between congruence, child gender, and child type was added, which again improved model fit (*AIC* = 18960, $\chi^2(17) = 1161.6$, $p < .001$). Additionally, a three-way interaction between congruence, child type, and parents' gender attitudes about behavior was added, which also improved the model (*AIC* = 18948, $\chi^2(2) = 15.3$, $p < .001$) but adding a three-way interaction between congruence, child gender, and parents' gender attitudes did not ($p = .744$).

P3

Adding the main effects of congruence, child gender, and child type significantly improved model fit compared to the intercept only model (*AIC* = 17559, $\chi^2(5) = 88.9$, $p < .001$), but the main effects of parent gender and parents' gender attitudes did not significantly improve model fit ($p = .828$). Adding interactions between congruence and child gender, and congruence and child type also significantly improved model fit (*AIC* = 16789, $\chi^2(20) = 810.3$, $p < .001$), as did the three-way interaction between these variables (*AIC* = 15714, $\chi^2(17) = 1108.6$, $p < .001$).

Late positive potential

Lastly, for the LPP model, the main effects of congruence, child gender, and child type significantly improved model fit (*AIC* = 19485, $\chi^2(5) = 303.6$, $p < .001$) but adding the main effect of parents' gender attitudes and parent gender did not ($p = .296$). Adding the two-way interactions between congruence and child gender and congruence and child type also significantly improved model fit (*AIC* = 18105, $\chi^2(20) = 1420.6$, $p < .001$). Finally, the three-way interaction between congruence, child gender, and child type also decreased AIC and BIC values for the LPP mean amplitude model ($AIC = 17297, \chi^2(17) = 842.2, p < .001$).

Parents' neural responses towards the violation of gender stereotypes about toys

P1

The final model with P1 mean amplitude as dependent variable included a main effect of congruence, child type and child gender, as well as a three-way interaction between these three variables. Congruence did not significantly predict P1 mean amplitudes ($p = .735$), nor were any of the interaction effects between congruence and the predictors significant (lowest p-value = .109 for the interaction between congruence and child gender). Child type was a significant predictor of P1 mean amplitudes ($\beta = .10, t(135) = 3.24, p = .002$). Parents' P1 mean amplitudes were significantly larger towards their own versus unknown children.

N1

The final model included congruence, child gender, and child type as main effects, and an interaction between congruence and child type as interaction effect. N1 mean amplitudes were not predicted by congruence ($p = .621$). Significant main effects were found for child gender ($\beta = .02$, t(135) = 3.23, $p = .001$) and child type ($\beta = .12, t(135) = 6.19, p < .001$). A stronger N1 effect was observed towards girls than boys or towards unknown children than own children. The interaction between congruence and child type was not significant ($p = .615$).

P2

The final model included a main effect of congruence, child type and child gender, as well as a three-way interaction between these three variables. A main effect of child type was found for P2 amplitudes ($\beta = .16, t(135) = 5.02, p < .001$). Parents' P2 mean amplitudes were more positive towards their own than unknown children. None of the other main effects were significant (smallest p-value = .774), nor did the two-way and three-way interactions yield a significant result ($p = .667$).

P3

Similar to the previous components the final model included a main effect of congruence, child gender, and child type, as well as two- and three-way interactions between these three variables. Again, only child type yielded a significant result for P3 mean amplitudes (β -.07, $t(135)$ -2.09, p .039). P3 amplitudes were larger during trials with unknown children than parents' own children. The main effect of congruence was not significant (p = .165) nor were the interactions significant (lowest p-value = .216).

Late positive potential

Again, the final model included a main effect of congruence, child gender, and child type, as well as the two- and three-way interactions between these variables. There was no significant main effect of congruence on LPP mean amplitudes (p = .620), nor were significant interaction effects found (lowest p-value = .463). Again, a main effect for child type was found (β = .11, t(135) = 3.86, p < .001). Parents' LPP amplitudes were larger during trials that included their own children than unknown children.

Parents' neural responses towards the violation of gender stereotypes about behavior uncorrected results

N1

A main effect was found for congruence (β = .07, t(135) = 2.50, p = .013) and child type (β = .11, t(135) = 4.98, p < .001). N1 mean amplitudes were more negative towards congruent trials and towards unknown children. Moreover, the two-way interactions between congruence and child gender (β = -.05, t(135) = -2.13, p = .038) and between congruence and parents' gender attitudes about behavior towards their own children (β = -.03, t(135) = -2.27, p = .025) were significant. Regarding the interaction between congruence and child gender, N1 amplitudes were less strong during incongruent trials than congruent trials for boys (β = .07, t(179) = 2.285, p = .023), but this was not found for girls (p = .876). Moreover, as can be seen in Figure S4.3, when parents had stronger gender attitudes about behavior, the difference in N1 mean amplitudes between congruent and incongruent trials became larger.

P2

A significant main effect was found for congruence (β = .09, t(135) = 3.01, p = .003), child gender (β = .05, t(135) = 2.16, p = .033), and child type (β = .09, t(135) = 2.45, p = .015). P2 amplitudes were more positive during incongruent trials than congruent trials, towards girls than boys, and towards their own children than unknown children. Additionally, a significant main effect of parents' gender attitudes about behavior was found (β = -.21, t(135) = -2.66, p = .009). P2 amplitudes were weaker when parents held more traditional gender attitudes. Moreover, a significant interaction was found between congruence and child gender (β = -.09, t(135) = -3.40, p < .001). Running the model separately for trials with boys and trials with girls revealed that for boys, parents P2 amplitudes were larger during incongruent trials than during congruent trials (β = .10, $t(181)$ = 2.75, p = .007). For girls, there was no main effect of congruence (β = .03, $t(195)$ = 0.89, p = .376). Lastly, a significant interaction was found between child type and parents' gender attitudes about behavior (β = .14, $t(135)$ = 3.35, p = .001).

Late positive potential

Significant main effects were found for congruence (β = .04, $t(135)$ = 2.04, p = .044) and child type (β = .13, $t(135)$ = 5.22, p < .001). LPP mean amplitudes were larger during incongruent trials and during trials that included parents' own children than unknown children. Moreover, a significant interaction was found between congruence and child gender (β = -.07, $t(135)$ = -2.86, p = .005). Subsequent analyses revealed that parents' LPP amplitudes were more positive during incongruent trials than during congruent trials for boys (β = .05, $t(135)$ = 2.04, p = .044), but this effect of congruence was not found for girls (β = -.04, $t(135)$ = -1.48, p = .141).

Findings in the neural components corrected for the preceding component unrelated to congruence

N1

With regard to N1 amplitudes, a significant main effect of parents' gender attitudes on N1 amplitudes was found; parents' N1 responses towards congruent and incongruent child-behavior combinations were stronger when parents held more traditional gendered attitudes about behavior (β = -.05, $t(135)$ = -2.01, p = .047).

P2

A significant interaction was found between child type and parents' gender attitudes about behavior (β = .05, $t(135)$ = 2.63, p = .010). When parents held stronger gender attitudes about behavior (i.e., rated congruent trials as more appropriate than incongruent trials), parents' P2 amplitudes towards unknown children decreased, but parents' gender attitudes about behavior did not affect parents' P2 mean amplitudes towards their own children, see Figure S4.4.

Post-hoc examination of congruence effects in N400 mean amplitudes.

The effects of congruence for the N400 mean amplitudes were post-hoc examined for several reasons. First, we based our ERP selection on previous studies that examined congruence effects with a similar task design (e.g., Portengen et al., 2022) that did not include the N400 in their ERP component selection. Second, the N400 has mainly shown effects in response to linguistic priming rather than in response to face-word combinations (e.g., (Franklin et al., 2007; Rodríguez-Gómez et al., 2020). Third, the N400 effect can be obscured when LPP responses are measured (Franklin et al., 2007). However, since the N400 has also been found to be modulated in response to stereotyped information (e.g., White et al., 2009), we post-hoc examined the effect of congruence in N400 mean amplitudes.

In order to do this, N400 mean amplitudes were exported from the fronto-central electrodes (Fz, Cz, Pz, FC1, FC2, C3, C4) in the 300-500ms time window (in accordance with White et al. (2009). The analyses revealed no effect of congruence on N400 mean amplitudes in the toy or the behavior block, nor were any of the interactions significant.

The final N400 mean amplitude models included a main effect of congruence, child gender, and child type, as well as an interaction between congruence and child gender and congruence and child type. For the N400 mean amplitude model in the behavior block, an additional higher-order interaction was added between child gender, child type, and congruence.

There was no significant main effect of congruence in the N400 toy block model (β = -.03, $t(136) = -0.70$, $p = .485$). Moreover, no significant interaction was found between congruence and child gender (β = .01, $t(136) = 0.35$, $p = .725$) or congruence and child type (β = .01, $t(136) = 0.40$, $p = .691$). Similarly, no main effect of congruence was found in the N400 behavior block model (β = -.01, $t(135) = -1.03$, $p = .695$) nor were the interaction between congruence and child gender or congruence and child type significant (child gender: β = .03, $t(135) = 0.97$, $p = .332$; child type: β = .03, t(135) = 1.04, $p = .300$). Last, no significant three-way interaction emerged between congruence, child gender, and child type (β = -.04, $t(135) = -1.36$, $p = .176$).

References

Franklin, M. S., Dien, J., Neely, J. H., Huber, E., & Waterson, L. D. (2007). Semantic priming modulates the N400, N300, and N400rp. *Clinical Neurophysiology*, *118*(5), 1053-1068. https://doi.org/10.1016/j.clinph.2007.01.012

Portengen, C. M., Huffmeijer, R., van Baar, A. L., & Endendijk, J. J. (2022). Measuring the neural correlates of the violation of social expectations: A comparison of two experimental tasks. *Social Neuroscience*, *17*(1), 58-72. https://doi.org/10.1080/17470919.2022.2032327

Rodríguez-Gómez, P., Romero-Ferreiro, V., Pozo, M. A., Hinojosa, J. A., & Moreno, E. M. (2020). Facing stereotypes: ERP responses to male and female faces after gender-stereotyped statements. *Social Cognitive and Affective Neuroscience*, *15*(9), 928-940. https://doi.org/10.1093/scan/nsaa117

White, K. R., Crites, S. L., Jr., Taylor, J. H., & Corral, G. (2009). Wait, what? Assessing stereotype incongruities using the N400 ERP component. *Social Cognitive and Affective Neuroscience*, *4*(2), 191-198. https://doi.org/10.1093/scan/nsp004

Table S4.1. Results from the multilevel models examining congruence effects on ERP mean amplitudes during toy trials.

P1	*b*	*β*	*SE*	*t*(df)	*p*
Congruence	0.06	-.01	.16	-0.34 (135)	.735
Child gender	0.20	.03	.13	1.51 (135)	.132
Child type	0.64*	.10	.20	3.24 (135)	.002
Congruence*child gender	-0.34	-.05	.21	-1.62 (135)	.109
Congruence*child type	-0.02	-.002	.29	-0.07 (135)	.943
Child gender*child type	-0.01	-.002	.25	-0.06 (135)	.956
Congruence*child gender*child type	0.01	.001	.39	0.03 (135)	.974
N1	*b*	*β*	*SE*	*t*(df)	*p*
Congruence	-0.07	-.01	.13	-0.49 (136)	.621
Child gender	0.11*	.02	.03	3.23 (135)	.001
Child type	0.79*	.12	.13	6.19 (135)	<.001
Congruence*child type	-0.10	-.01	.21	-0.50 (135)	.615
P2	*b*	*β*	*SE*	*t*(df)	*p*
Congruence	0.01	.001	.16	0.05 (135)	.960
Child gender	0.04	.01	.14	0.29 (135)	.774
Child type	0.88*	.16	.18	5.02 (135)	<.001
Congruence*child gender	-0.09	-.01	.22	-0.41 (135)	.680
Congruence*child type	-0.08	-.01	.24	-0.34 (135)	.732
Child gender*child type	-0.06	-.01	.23	0.25 (135)	.800
Congruence*child gender*child type	-0.16	-.02	.36	-0.43 (135)	.667
P3	*b*	*β*	*SE*	*t*(df)	*p*
Congruence	0.19	.04	.14	1.40 (135)	.165
Child gender	-0.05	-.01	.11	-0.48 (135)	.630
Child type	-0.34*	-.07	.16	-2.09 (135)	.039
Congruence*child gender	-0.20	-.04	.16	-1.24 (135)	.216
Congruence*child type	-0.10	-.02	.23	-0.44 (135)	.658
Child gender*child type	0.10	.02	.17	0.56 (135)	.575
Congruence*child gender*child type	0.11	.02	.25	0.46 (135)	.646
Late Positive Potential	*b*	*β*	*SE*	*t*(df)	*p*
Congruence	-0.10	-.01	.19	-0.50 (135)	.620
Child gender	-0.12	-.02	.19	-0.61 (135)	.543
Child type	0.84*	.11	.22	3.86 (135)	<.001
Congruence*child gender	0.19	.02	.26	0.74 (135)	.463

Table S4.1. *(continued)*

Congruence*child type	0.08	.01	.26	0.33 (135)	.745
Child gender*child type	-0.12	-.01	.24	-0.50 (135)	.619
Congruence*child gender*child type	-0.0004	-.00004	.37	-0.001 (135)	.999

Note. GAT = gender attitudes about toys. Child type refers to the difference between parents' own children and unknown children. Congruent, boy, unknown child, and father were the reference categories for congruence, child gender, child type, and parent gender, respectively.
The asterisk indicates significant effects with $p < .05$.

Table S4.2. Results from the multilevel models examining congruence effects on ERP mean amplitudes during behavior trials.

N1	*b*	*ß*	*SE*	*t*(df)	*p*
Congruence	0.48*	.07	.19	2.50 (135)	.013
Child gender	0.18	.03	.10	1.82 (135)	.071
Child type	0.76*	.11	.15	4.98 (135)	<.001
Parent gender	-0.22	-.03	.35	-0.61 (135)	.545
GAB	-0.23	-.05	.25	-0.94 (135)	.349
Congruence*GAB	-0.25*	-.04	.10	-2.54 (135)	.012
Congruence*child gender	-0.36*	-.05	.17	-2.13 (135)	.035
Congruence*child type	-0.01	-.001	.20	-0.03 (135)	.976
Congruence*parent gender	-0.19	-.02	.14	-1.31 (135)	.191
P2	*b*	*ß*	*SE*	*t*(df)	*p*
Congruence	0.52*	.09	.17	3.01 (135)	.003
Child gender	0.27*	.05	.12	2.16 (135)	.033
Child type	0.51*	.09	.21	2.45 (135)	.015
Parent gender	-0.09	-.01	.28	-0.31 (77)	.754
GAB	-0.83*	-.21	.31	-2.66 (133)	.009
Congruence*GAB	-0.25	-.05	.14	-1.78 (135)	.077
Congruence*child gender	-0.59*	-.09	.17	-3.40 (135)	<.001
Congruence*child type	-0.32	-.05	.25	-1.24 (135)	.218
Child gender*child type	-0.36	-.05	.19	-1.94 (135)	.055
Child type*GAB	0.63*	.14	.19	3.35 (135)	.001
Congruence*child gender*child type	0.47	.05	.31	1.51 (135)	.133
Congruence*child type*GAB	0.07	.01	.24	0.31 (135)	.757
Late Positive Potential	*b*	*ß*	*SE*	*t*(df)	*p*
Congruence	0.34*	.04	.17	2.04 (135)	.044
Child gender	0.26	.03	.15	1.75 (135)	.083
Child type	1.01*	.13	.19	5.22 (135)	<.001
Congruence*child gender	-0.60*	-.07	.21	-2.86 (135)	.005
Congruence*child type	0.09	.01	.21	0.45 (135)	.655
Child gender*child type	-0.16	-.02	.25	-0.65 (135)	.519
Congruence*child gender*child type	0.03	.003	.42	0.08 (135)	.936

Note. GAB = gender attitudes about behavior. Congruent, boy, unknown child, and father were the reference categories for congruence, child gender, child type, and parent gender, respectively.
The asterisk indicates significant effects with $p < .05$.

Table S4.3. Zero-order correlations between the ERP mean amplitudes during the behavior block and children's parent-reported internalizing and externalizing behaviors.

	Dau Internalizing	Son Internalizing	Dau Externalizing	Son Externalizing
P1 Pz boy con	-0.041	0.076	0.143	0.028
P1 Pz boy incon	-0.062	0.071	0.157	-0.009
P1 Pz girl con	-0.067	0.034	0.134	0.099
P1 Pz girl incon	-0.058	0.132	0.157	0.131
P1 Pz son con	-0.017	0.040	0.110	0.169
P1 Pz son incon	-0.002	0.051	0.200	0.077
P1 Pz dau con	0.014	0.024	0.071	0.078
P1 Pz dau incon	-0.060	0.116	0.161	0.041
P1 P3 boy con	-0.049	0.124	0.179	0.065
P1 P3 boy incon	-0.031	0.116	0.132	0.047
P1 P3 girl con	-0.053	0.094	0.108	0.102
P1 P3 girl incon	0.002	0.164	0.172	0.153
P1 P3 son con	0.006	0.148	0.205	0.189
P1 P3 son incon	0.047	0.148	0.181	0.146
P1 P3 dau con	0.050	0.167	0.154	0.184
P1 P3 dau incon	-0.030	0.206	0.148	0.066
P1 P4 boy con	-0.057	0.101	0.158	0.040
P1 P4 boy incon	-0.078	0.104	0.148	0.025
P1 P4 girl con	-0.065	0.061	0.164	0.095
P1 P4 girl incon	-0.015	0.132	0.186	0.111
P1 P4 son con	0.000	0.096	0.178	0.157
P1 P4 son incon	-0.074	0.055	0.130	0.068
P1 P4 dau con	0.011	0.051	0.129	0.036
P1 P4 dau incon	-0.012	0.149	0.150	0.041
P1 PO3 boy con	-0.052	0.124	0.164	0.038
P1 PO3 boy incon	-0.007	0.125	0.152	-0.006
P1 PO3 girl con	-0.041	0.054	0.114	0.058
P1 PO3 girl incon	0.009	0.120	0.176	0.130
P1 PO3 son con	0.026	0.094	0.129	0.159
P1 PO3 son incon	0.044	0.035	0.161	0.152
P1 PO3 dau con	0.051	0.120	0.136	0.107
P1 PO3 dau incon	-0.006	0.184	0.119	0.055
P1 PO4 boy con	-0.048	0.061	0.167	0.044
P1 PO4 boy incon	-0.053	0.079	0.159	0.024

Table S4.3. *(continued)*

	Dau Internalizing	Son Internalizing	Dau Externalizing	Son Externalizing
P1 PO4 girl con	-0.087	0.029	0.125	0.058
P1 PO4 girl incon	-0.012	0.118	0.165	0.124
P1 PO4 son con	-0.028	0.069	0.182	0.129
P1 PO4 son incon	-0.025	0.016	0.192	0.106
P1 PO4 dau con	-0.019	0.024	0.151	0.039
P1 PO4 dau incon	-0.021	0.148	0.156	0.067
P1 O1 boy con	-0.092	0.156	0.143	0.035
P1 O1 boy incon	-0.055	0.090	0.120	-0.021
P1 O1 girl con	-0.062	0.047	0.090	0.044
P1 O1 girl incon	-0.043	0.118	0.111	0.083
P1 O1 son con	-0.051	0.074	0.093	0.056
P1 O1 son incon	0.001	0.017	0.109	0.110
P1 O1 dau con	-0.044	0.088	0.073	0.012
P1 O1 dau incon	-0.020	0.151	0.066	0.046
P1 O2 boy con	-0.078	0.086	0.178	0.057
P1 O2 boy incon	-0.116	0.041	0.137	-0.023
P1 O2 girl con	-0.117	0.044	0.171	0.054
P1 O2 girl incon	-0.038	0.085	0.130	0.079
P1 O2 son con	-0.021	0.049	0.186	0.077
P1 O2 son incon	-0.015	-0.004	0.216	0.077
P1 O2 dau con	-0.108	0.035	0.141	-0.006
P1 O2 dau incon	-0.002	0.138	0.137	0.021
P1 Oz boy con	-0.077	0.124	0.181	0.033
P1 Oz boy incon	-0.077	0.057	0.147	-0.013
P1 Oz girl con	-0.060	0.013	0.155	0.060
P1 Oz girl incon	-0.032	0.088	0.134	0.088
P1 Oz son con	-0.034	0.078	0.124	0.032
P1 Oz son incon	0.018	-0.004	0.144	0.065
P1 Oz dau con	-0.092	0.032	0.092	0.011
P1 Oz dau incon	-0.006	0.096	0.100	0.063
P3 FC1 boy con	0.116	-0.092	-0.068	0.082
P3 FC1 boy incon	-0.058	-0.113	0.064	0.146
P3 FC1 girl con	0.059	0.066	-0.026	0.153
P3 FC1 girl incon	-0.045	-0.030	-0.020	0.143
P3 FC1 son con	-0.082	0.070	0.022	0.073

Table S4.3. *(continued)*

	Dau Internalizing	Son Internalizing	Dau Externalizing	Son Externalizing
P3 FC1 son incon	-0.049	0.004	-0.034	0.028
P3 FC1 dau con	-0.050	-0.073	0.081	0.080
P3 FC1 dau incon	0.050	0.007	0.166	0.113
P3 FC2 boy con	0.007	-0.178	-0.043	0.151
P3 FC2 boy incon	-0.137	-0.101	-0.008	0.144
P3 FC2 girl con	-0.014	0.005	-0.029	0.123
P3 FC2 girl incon	-0.050	-0.093	-0.077	0.016
P3 FC2 son con	-0.079	0.047	-0.035	0.124
P3 FC2 son incon	-0.004	0.014	-0.152	0.002
P3 FC2 dau con	-0.045	-0.118	0.060	0.044
P3 FC2 dau incon	0.004	0.011	0.160	0.064
P3 Fz boy con	0.089	-0.087	-0.165	0.038
P3 Fz boy incon	0.015	-0.076	-0.113	0.076
P3 Fz girl con	0.153	0.034	-0.152	0.048
P3 Fz girl incon	0.021	-0.077	-0.172	0.034
P3 Fz son con	-0.042	0.017	-0.163	-0.041
P3 Fz son incon	-0.007	-0.001	-0.176	-0.053
P3 Fz dau con	-0.055	-0.114	-0.074	-0.005
P3 Fz dau incon	0.033	0.019	0.040	0.131
P3 Cz boy con	-0.059	-0.034	0.042	0.146
P3 Cz boy incon	-0.187	-0.038	0.109	0.055
P3 Cz girl con	-0.050	0.091	0.059	0.186
P3 Cz girl incon	-0.065	0.044	0.071	0.094
P3 Cz son con	-0.114	0.063	0.043	0.177
P3 Cz son incon	-0.039	0.050	0.046	0.045
P3 Cz dau con	-0.042	-0.032	0.073	0.111
P3 Cz dau incon	-0.012	-0.006	0.201	0.089
LPP P3 boy con	-0.116	0.002	0.153	-0.019
LPP P3 boy incon	-0.062	0.043	0.100	-0.021
LPP P3 girl con	-0.063	0.003	0.081	0.000
LPP P3 girl incon	-0.042	0.053	0.156	0.024
LPP P3 son con	-0.030	0.037	0.182	0.074
LPP P3 son incon	-0.007	0.030	0.081	0.044
LPP P3 dau con	-0.022	-0.007	0.087	0.006
LPP P3 dau incon	-0.048	0.068	0.098	-0.055

Table S4.3. *(continued)*

	Dau Internalizing	Son Internalizing	Dau Externalizing	Son Externalizing
LPP P4 boy con	-0.083	0.011	0.135	0.022
LPP P4 boy incon	-0.086	-0.016	0.138	0.049
LPP P4 girl con	-0.074	-0.047	0.116	0.065
LPP P4 girl incon	-0.021	0.029	0.098	0.075
LPP P4 son con	0.027	0.004	0.094	0.103
LPP P4 son incon	-0.045	-0.006	0.070	0.100
LPP P4 dau con	-0.042	-0.117	0.034	0.055
LPP P4 dau incon	-0.010	0.011	0.087	0.022
LPP PO3 boy con	-0.123	0.064	0.179	-0.032
LPP PO3 boy incon	-0.028	0.062	0.133	-0.011
LPP PO3 girl con	-0.100	-0.010	0.114	-0.006
LPP PO3 girl incon	-0.065	0.042	0.168	0.062
LPP PO3 son con	0.010	0.044	0.110	0.046
LPP PO3 son incon	-0.013	0.047	0.103	0.059
LPP PO3 dau con	0.000	0.018	0.089	0.016
LPP PO3 dau incon	0.005	0.102	0.074	-0.047
LPP PO4 boy con	-0.112	-0.007	0.126	0.069
LPP PO4 boy incon	-0.083	0.011	0.147	0.044
LPP PO4 girl con	-0.118	-0.045	0.065	0.033
LPP PO4 girl incon	-0.072	0.057	0.114	0.126
LPP PO4 son con	0.013	0.016	0.094	0.076
LPP PO4 son incon	-0.030	-0.015	0.128	0.135
LPP PO4 dau con	-0.076	-0.097	0.037	0.041
LPP PO4 dau incon	-0.035	0.043	0.073	0.052

Note. con = congruent. incon = incongruent. dau = daughter. LPP = late positive potential.

Figure S4.1. Exemplar picture used for the instructions for the picture of the own child with neutral facial expression.

Figure S4.2. Grand average waveforms per condition, separate for the toy and behavior block.

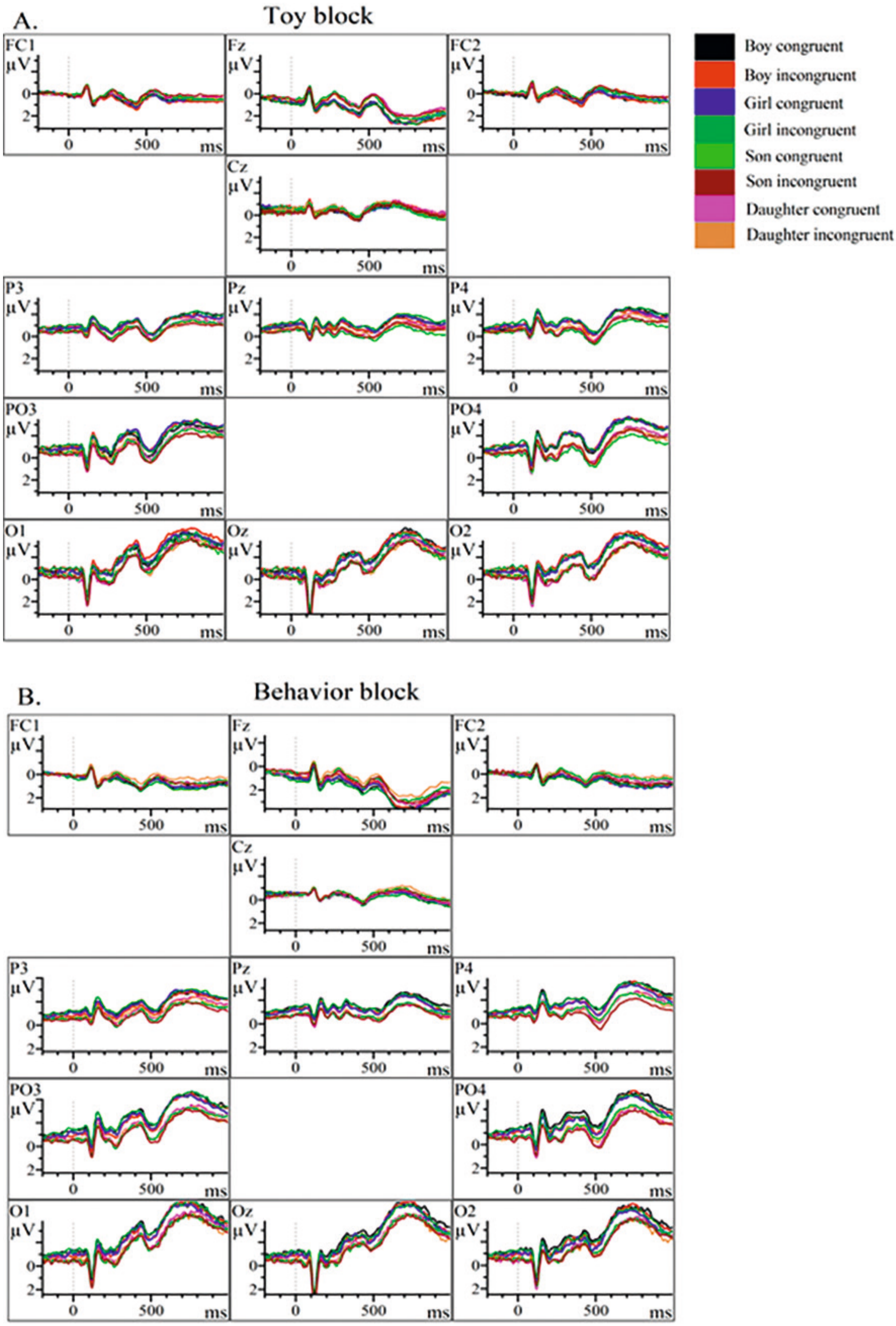


Figure S4.3. The effect of parents' gender attitudes about child problem behavior on parents' N1 amplitudes during congruent and incongruent trials. Panel A depicts the separate effects of congruent (black) and incongruent (grey) trials. Panel B depicts the difference in N1 amplitudes during incongruent-congruent trials.

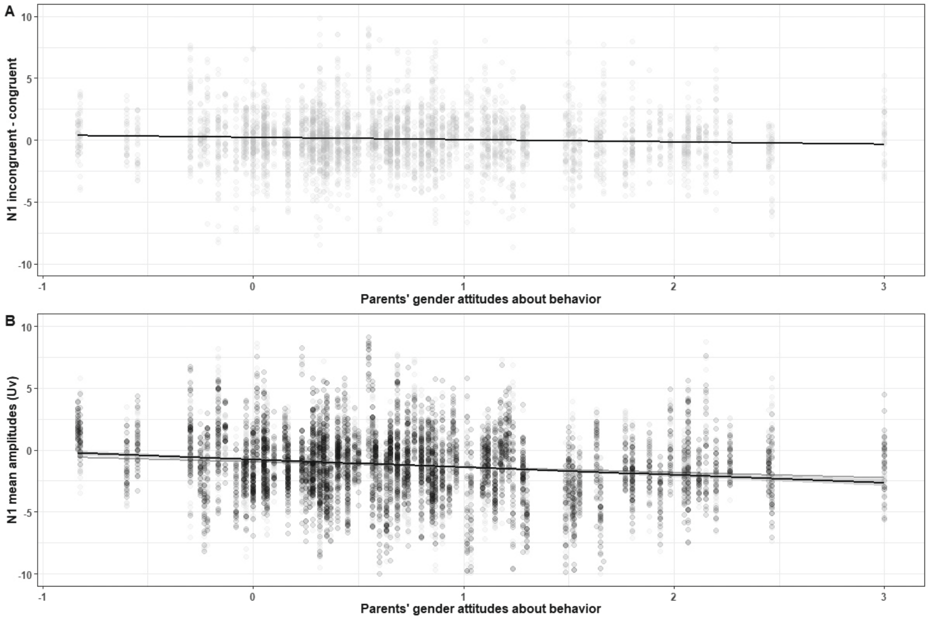
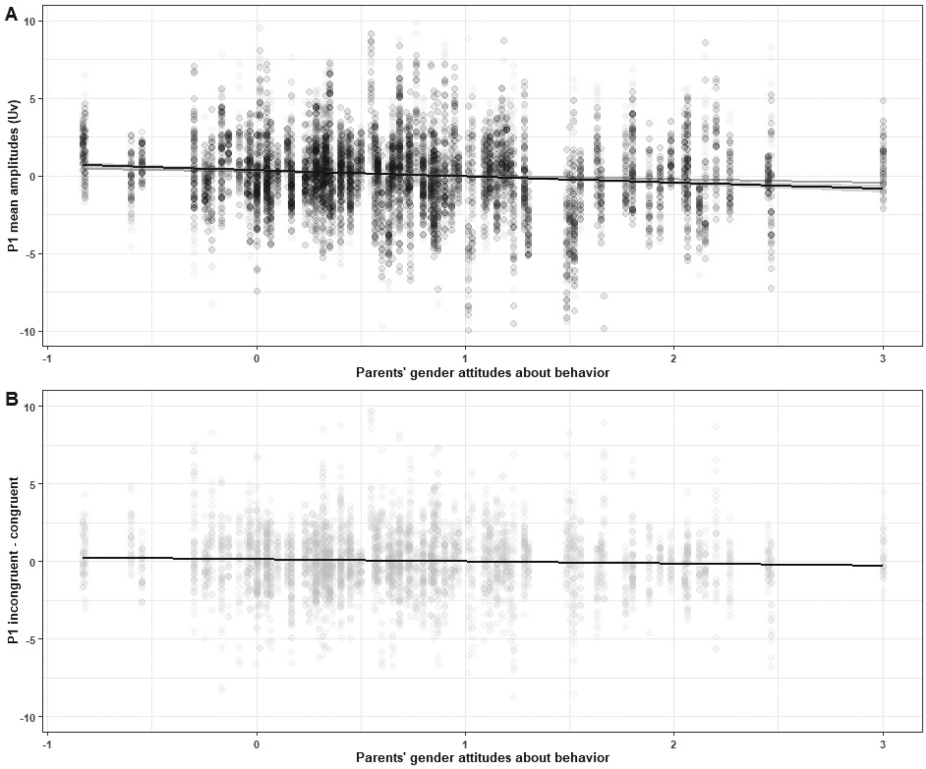


Figure S4.4. Effect of parents' gender attitudes about child problem behavior on parents' P2 mean amplitudes, separate for unknown children (black line) and their own children (grey line).



Appendix C: Chapter 5 supplementary materials

Table S5.1. Correlation matrix for fathers' and mothers' report of child internalizing and externalizing behavior and emotional expressions.

	1.	2.	3.	4.	5.	6.	7.	8.
1. Mother internalizing daughter								
2. Father internalizing daugher	.34**							
3. Mother internalizing son	.34**	.12						
4. Father internalizing son	-.09	.28*	.47***					
5. Mother externalizing daughter	-.06	.06	.04	.24*				
6. Father externalizing daughter	-.18	.24*	.06	.43***	.50***			
7. Mother externalizing son	.37**	.16	.26*	-.25*	.08	-.13		
8. Father externalizing son	.17	.36**	.21	.07	-.05	.34**	.42***	

Note. $^{*}p < .05$; $^{**}p < .01$, $^{***}p < .001$

Supplementary sensitivity analyses

Parent gender

Parent gender was not a significant predictor in any of the models (smallest *p*-value = .072). Adding parent gender to the LPP models predicting sad or fearful labeling led to convergence issues and these were thus omitted. Including parent gender as predictor in the P1 model predicting boy labeling during sad child pictures only changed the slope, but not the direction or the significance level of the findings.

Child age

Child age significantly improved model fits of models predicting parents' use of the label 'girl' to identify the sad child character. Adding child age to these models revealed a significant negative main effect of son's age; parents of younger sons were more likely to use 'girl' to label the sad child character during picture book reading (b = -0.44, SE = 0.21, p = .036). Adding child age to the P1 and LPP models predicting parents' use of label 'boy' to identify the angry child character revealed a significant main effect of daughter age (P1: b = 0.63, SE = 0.26, p = .014; LPP: b = 0.64, SE = 0.26, p = 0.014). Parents' use of gender-congruent labels to identify angry child character became more frequent when daughter's age increased. However, these effects did not survive multiple comparison correction. Adding child age to the other models led to convergence issues and this variable was thus omitted.

Mother vs. father-report

To examine whether findings would differ depending on mother- of father-report of child behavior, analyses were done separately, once with mother-reports and once with father-reports of internalizing and externalizing behavior and emotional expressions. Mother-reports of son's and daughter's internalizing and externalizing behavior and emotions were not significantly related to parents' use of gender labels during picture book reading ($ps > .086$) nor did other significant associations emerge. Father-reports of son's and daughter's internalizing and externalizing behavior and emotion symptoms yielded the same results: No significant relations were found between father-reported internalizing and externalizing behavior and emotions and father's use of gender labels to identify emotional child characters ($ps > .051$) nor did other significant associations emerge. In both cases, the P1 model predicting the use of the label 'boy' to identify the sad child character led to convergence issues and was thus omitted.

Appendix D: Chapter 6 supplementary materials

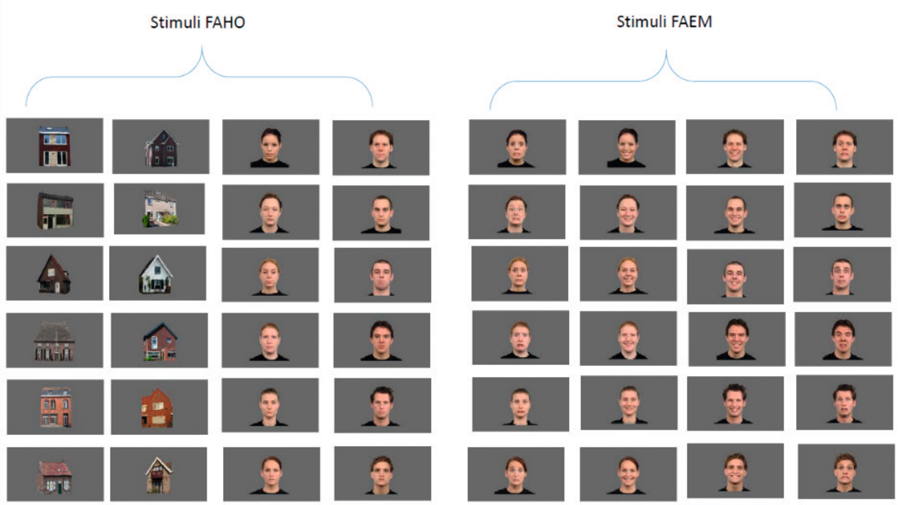
Supplementary analyses

To directly compare gender stereotype-confirming emotional faces (i.e., happy and fearful female faces) with gender stereotype-violating emotional faces (i.e., happy and fearful male faces), the mean amplitude scores towards happy and fearful emotion condition were averaged. These analyses were run to examine if results would differ from the reported analyses that tested each emotion separately. The findings for the happy face condition in the early two components were replicated. Thus, a main effect of condition was found on P1 mean amplitudes (β = -.061, $t(70)$= -2.01, p = .048) and on the uncorrected N290 mean amplitudes (β = -.054, $t(70)$ = -2.29, p = .025). Some small differences were observed regarding later components. In the uncorrected P400 amplitudes we again found a main effect of condition (β = -.059, $t(70)$ = -2.90, p = .005). Moreover, we found a significant interaction between child gender and condition on P400 mean amplitudes (β = .052, $t(70)$ = 2.12, p = .038). Lastly, the interaction between child gender and condition in the Nc component became marginally significant (β = -.094, $t(68)$ = -1.91, p .060).

Table S6.1. Descriptive statistics of children who were excluded versus included after EEG preprocessing.

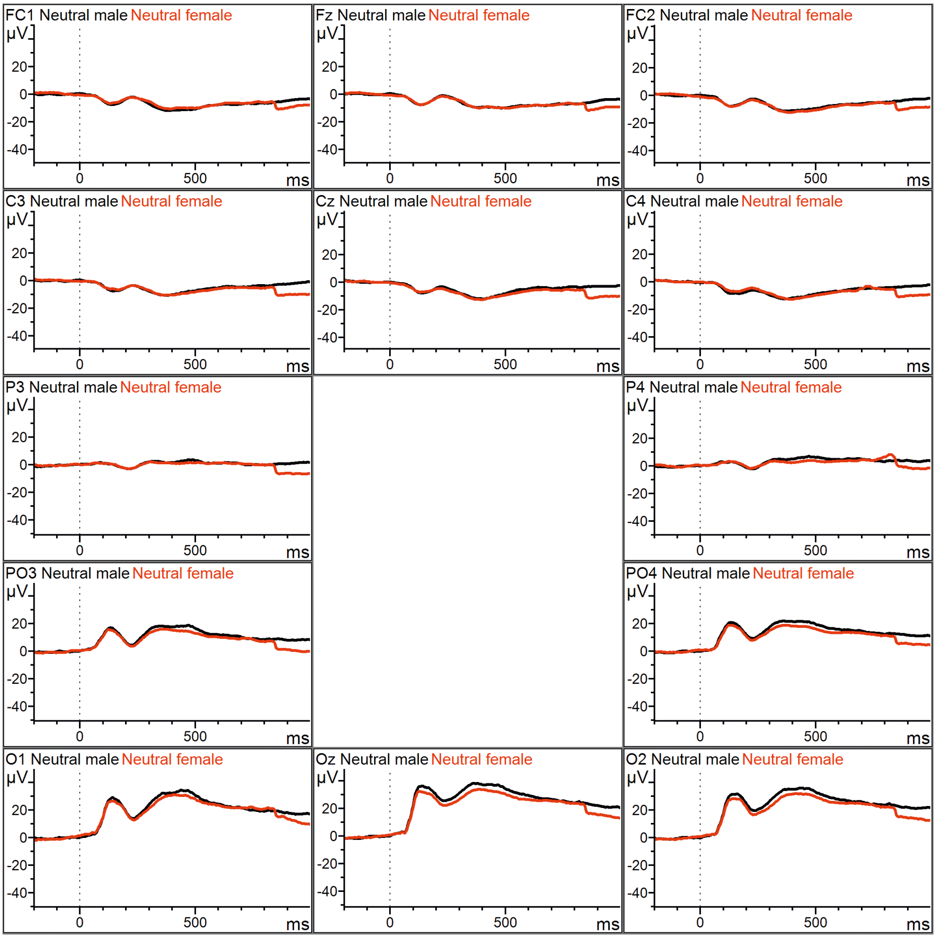
	Included (*n*=72)	Excluded (*n*=55)	test statistics (df)	*p*-value
Gender, *n* (%)			$\chi^2(1) = 0.43$	.511
Boy	33 (26.0%)	22 (17.3%)		
Girl	39 (30.7%)	33 (30.7%)		
Age in months, *M (SD)*	35.51 (4.04)	35.13 (3.95)	$F(1,125) = 0.29$	.590
Ethnicity mother, *n* (%)			$\chi^2(1) = 1.70$	.192
Dutch	65 (51.7%)	49 (40.8%)		
Other Western country	6 (5.0%)	3 (2.5%)		
Ethnicity father, *n* (%)			$\chi^2(2) = 0.93$	.661
Dutch	58 (53.7%)	47 (43.5%)		
Other non-Western country	-	1 (0.9%)		
Other Western country	1 (0.9%)	1 (0.9%)		
Family composition (mother), *n* (%)			$\chi^2(2) = 1.42$	.490
Living with partner only	-	1 (1.0%)		
Living with child(ren)	2 (2.0%)	2 (2.0%)		
Living with partner & child(ren)	56 (54.9%)	41 (40.2%)		
Family composition (father), *n* (%)			$\chi^2(2) = 0.90$	.636
Living with partner only	2 (2.0%)	2 (2.0%)		
Living with child(ren)	-	1 (1.0%)		
Living with partner & child(ren)	49 (50.0%)	44 (44.9%)		

Figure S6.1. Full set of stimuli used in the Face House Task and Face Emotion Task.



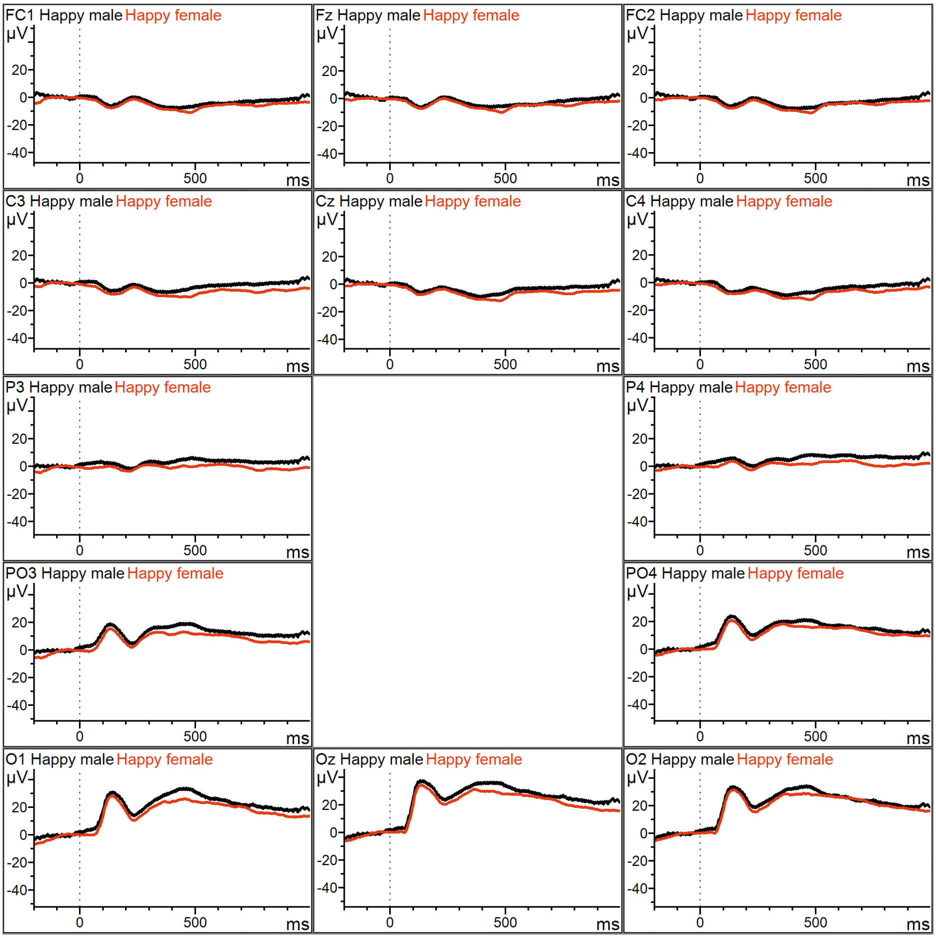
Note. FAHO = first part of the experiment, where children only saw houses and neutral faces; FAEO refers to the consecutive part, where children saw the same models but now only with smiling or fearful faces.

Figure S6.2. Grand average waveforms during the neutral face condition, separate for male and female faces.



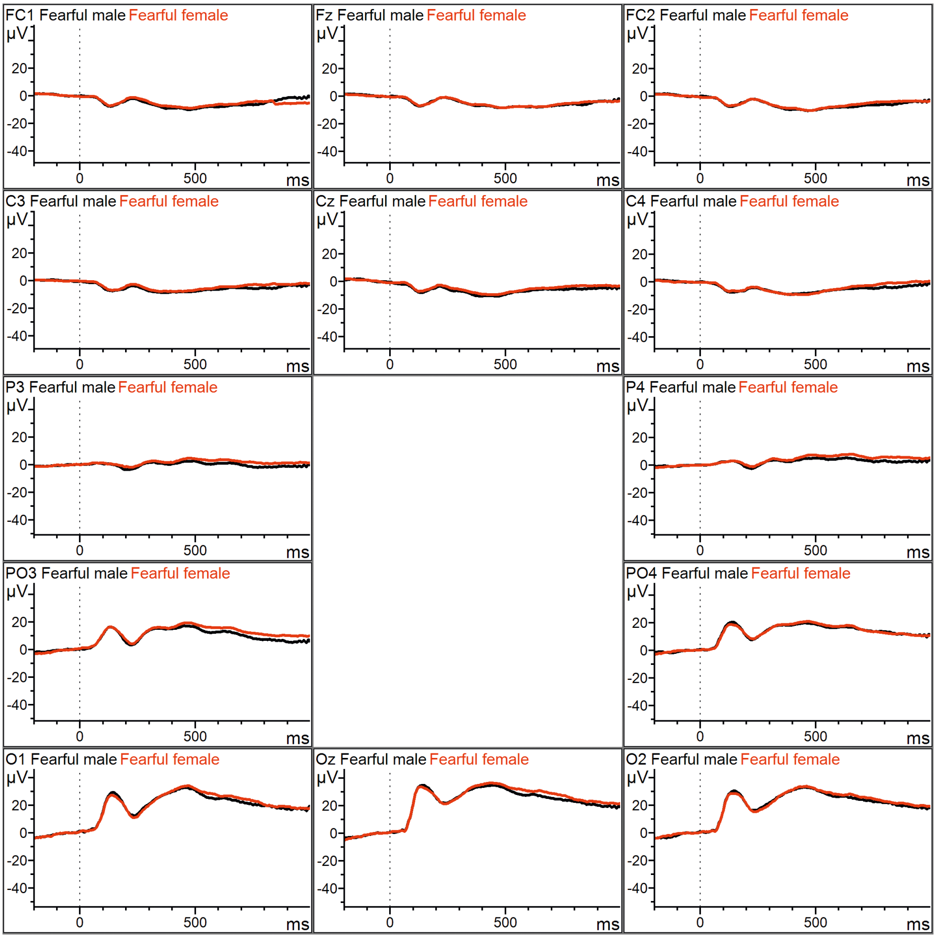
Note. Time in milliseconds is on X-axis (with 0 representing onset of visual stimulus) and amplitude is on the Y-axis (positive polarity plotted upwards). All electrodes are arranged according to layout: from left to right, and from frontal to posterior.

Figure S6.3. Grand average waveforms during the happy face condition, separate for male and female faces



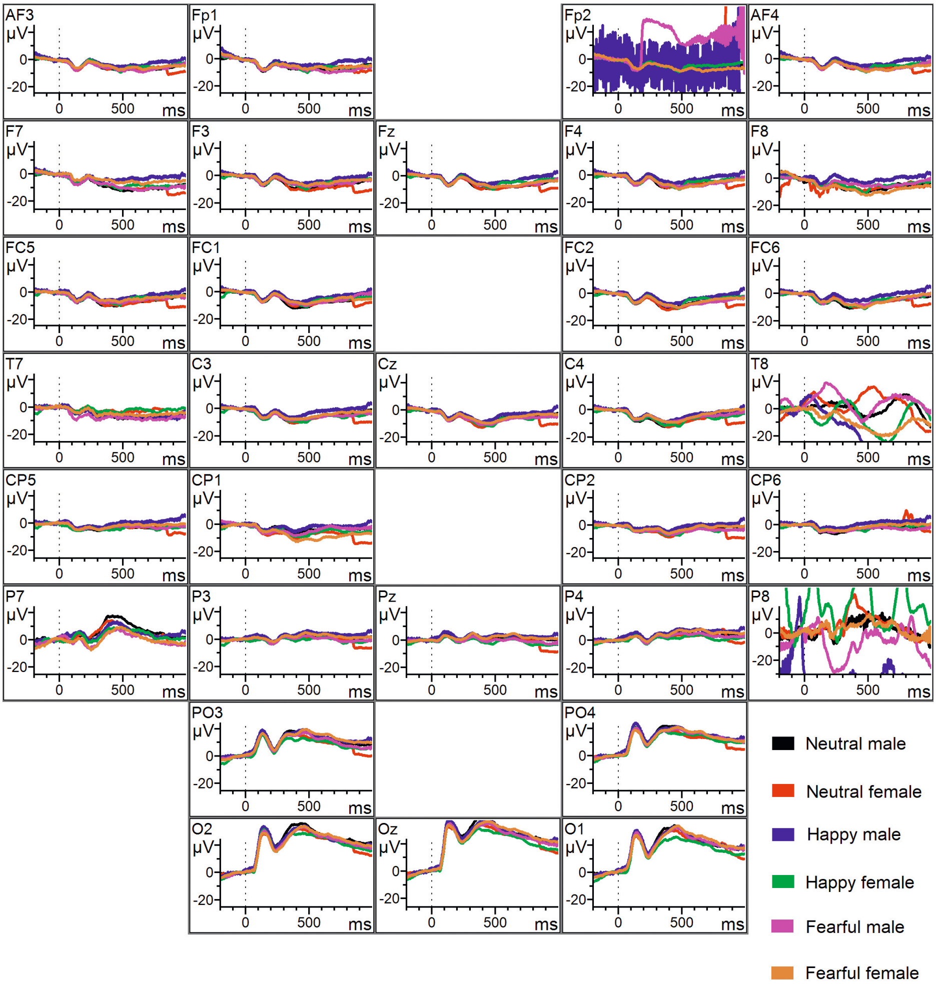
Note. Time in milliseconds is on X-axis (with 0 representing onset of visual stimulus) and amplitude is on the Y-axis (positive polarity plotted upwards). All electrodes are arranged according to layout: from left to right, and from frontal to posterior.

Figure S6.4. Grand average waveforms during the fearful face condition, separate for male and female faces.



Note. Time in milliseconds is on X-axis (with 0 representing onset of visual stimulus) and amplitude is on the Y-axis (positive polarity plotted upwards). All electrodes are arranged according to layout: from left to right, and from frontal to posterior.

Figure S6.5. Grand average waveforms during the neutral, happy, and fearful face condition, separate for male and female faces.



Note. Time in milliseconds is on X-axis (with 0 representing onset of visual stimulus) and amplitude is on the Y-axis (positive polarity plotted upwards). All electrodes are arranged according to layout: from left to right, and from frontal to posterior.

Summary

Nowadays, contrasting ways can be seen in which (future) parents approach gender. Next to a so-called 'gender-neutral baby movement' reflecting parents who do not want to reveal their baby's sex to the outside world, a rather massive trend of gender-reveal parties has emerged, in which parents announce the unborn baby's sex through extravagant reveals. So far little research has focused on *why* parents are more (or less) likely to use gender socialization in their home environment. Therefore, the aim of this dissertation was to examine the predictors and consequences of parental gender socialization in early childhood. Parental gender socialization encompasses all ways in which parents transmit gendered information onto their children.

To address this aim, one conceptual review of the literature was performed and data from three independent studies were analyzed and reported in four empirical papers. One study concerned electroencephalography (EEG) data of 25 young adults aged 22 – 31 years. This data was used for the empirical paper reported in chapter 3. The second study included families consisting of a father, a mother, and (at least) one son *and* one daughter aged 3 – 6 years. From the participating families, the following data was obtained: EEG data from parents, observations of parents with their participating children, and survey data. The two studies written using this data are reported in chapter 4 and 5. Last, the study reported in chapter 6 used EEG data of 72 children aged 2.5 – 3.5 years who had participated in the YOUth Cohort Study.

The first objective was to identify predictors of parental gender socialization from the literature. Regarding the cognitive factors, parents' gender stereotypes and attitudes and gendered attributions were found to be directly related to gender-differentiated parenting. Other cognitive factors (conflict resolution, gender essentialism, gender identity, intergroup attitudes, and internal motivation to parent without stereotypes) appeared to be related to gendered behavior in general. These factors were found to be of interest for parental gender socialization research. Regarding neural factors, brain areas associated with attentional processing, conflict monitoring, and reward processing appeared to be directly related to parental gender socialization. Brain areas related to behavior regulation were found to be modulated by gender stereotypes.

The second objective concerned the relation between parents' brain responses toward gender stereotypes and their gender socialization practices. To address this research question, it was first examined which of two frequently-used tasks elicited more robust patterns of brain

activity during EEG measurements. The Impression Formation Task (passive viewing paradigm) appeared to elicit more differences in the neural processing of gender-stereotype violations and gender-stereotype confirmations than the Implicit Association Test (response latency task). Second, it was examined whether parents and non-parents showed indications of differentiated neural processing of gender-stereotype violations and gender-stereotype confirmations. For both parents and non-parents, differentiated neural processing was observed in early visual processing, with more processing directed toward gender-stereotype violations than confirmations. Moreover, parents' early visual processing elicited by gender-stereotype confirmations from their own children appeared to be related to parents' use of gender labels during picture book reading with their children (parental gender socialization). Gender stereotypes additionally appeared to modulate neural processes related to motivational salience, but the direction differed. Parents' were found to show enhanced neural salience processing of gender-stereotype violations versus confirmations by their *own* children but this was not found for *unknown* children. For non-parents, salience processing was larger in response to pictures of children that confirmed rather than violated, gender stereotypes.

The third objective concerned the relation between children's gender-typed problem behaviors and parental gender socialization. In this dissertation, no evidence was found for the relation between children's internalizing and externalizing behaviors and parental gender socialization practices.

The final objective was to examine whether the effects of parental gender socialization were evident in preschool children's gender stereotypes. Findings indicated that 3-year-old children displayed preliminary signs of gender-stereotyping, as evidenced through enhanced neural activation patterns related to early attentional processing when viewing male happy faces compared to female happy faces. Moreover, it was found that 3-year-old boys and girls showed increased neural salience processing when viewing same-gender happy faces than when 3-year-old children viewed other-gender happy faces.

Overall, this dissertation demonstrates that parents' gender cognitions and parents' brain processes are related to their attentional processing, salience processing, conflict monitoring, and reward processing, and these factors are promising in explaining why some parents might engage in more traditional forms of gender socialization, whereas others might engage in more egalitarian ways of gender socialization. These early gender socialization practices in the family might have important consequences for children's gender development, for instance for the development of their own gender stereotypes.

Nederlandse samenvatting (Dutch summary)

Tegenwoordig komt een duidelijk onderscheid naar voren in de manier waarop (toekomstige) ouders omgaan met het geslacht en het gender van hun kind. Sommige ouders laten hun kind bewust zo genderneutraal mogelijk opgroeien, door bijvoorbeeld het geslacht van het kind niet bekend te maken, terwijl andere toekomstige ouders juist een speciaal feestje organiseren om het geslacht van hun toekomstige kind aan te kondigen aan hun sociale omgeving. Tot nu toe is er nog weinig onderzoek gedaan naar *waarom* sommige ouders meer geneigd zijn om ouderlijke gendersocialisatie toe te passen in de thuisomgeving dan andere ouders. Het doel van dit proefschrift was dan ook om de voorspellers en gevolgen van ouderlijke gendersocialisatie in kaart te brengen. Ouderlijke gendersocialisatie omvat alle manieren waarop ouders informatie over de sociale betekenis van gender overbrengen aan kinderen.

Om dit doel te bereiken is er een conceptueel literatuuroverzicht gemaakt en werden met data van drie onafhankelijke onderzoeken vier empirische studies uitgevoerd. Een van deze onderzoeken betrof elektro-encefalografie (EEG)-data van 25 jongvolwassenen met een leeftijd van 22 – 31 jaar. De studie in hoofdstuk 3 is geschreven met behulp van deze data. Het tweede onderzoek was uitgevoerd bij 74 gezinnen die bestonden uit een vader, een moeder, en minimaal één zoon *en* één dochter in de leeftijd van 3 t/m 6 jaar. De data van dit onderzoek bestond uit een EEG-meting, observaties van ouders met hun deelnemende kinderen, en vragenlijsten. Met behulp van deze data zijn de studies gerapporteerd in hoofdstuk 4 en 5 geschreven. Tot slot betrof de laatste studie, beschreven in hoofdstuk 6, EEG-data van 72 kinderen van 2,5 tot 3,5 jaar oud die hadden deelgenomen aan het YOUth-onderzoek.

De eerste onderzoeksvraag had als doel de cognitieve en neurale voorspellers van ouderlijke gendersocialisatie te identificeren in de wetenschappelijke literatuur. Het bleek dat verschillende cognitieve voorspellers direct gerelateerd waren aan ouderlijke gendersocialisatie, zoals ouderlijke genderstereotypen, genderattitudes en gender attributies. Andere cognitieve factoren, waaronder conflictresolutie, genderessentialisme, genderidentiteit, ingroup-outgroup attitudes en interne motivatie om zonder stereotypen op te voeden, bleken geassocieerd met meer algemeen gender-gerelateerd gedrag en zijn daardoor relevant voor onderzoek naar gendersocialisatie. Wat betreft de neurale processen toonde de literatuur aan dat verschillende hersengebieden en processen met betrekking tot aandachtverwerking, conflict monitoring en beloningsverwerking betrokken waren bij ouderlijke gendersocialisatie. Bovendien waren hersenprocessen gerelateerd aan gedragsregulatie ook betrokken bij de verwerking van genderstereotype informatie.

De tweede onderzoeksvraag richtte zich op de relatie tussen de neurale processen van ouders in reactie op genderstereotype informatie en ouderlijke gendersocialisatie. Om deze onderzoeksvraag te beantwoorden werd allereerst onderzocht welke van twee veelgebruikte associatietaken beter in staat was om neurale reacties op genderstereotype informatie uit te lokken tijdens een EEG-meting. Uit de resultaten kwam naar voren dat de Impressie Formatie Taak duidelijkere verschillen in neurale reacties op genderstereotype versus contrastereotype informatie uitlokte dan de Impliciete Associatie Test. Vervolgens werden de neurale reacties van ouders en van volwassenen zonder kinderen gemeten op genderstereotype en gender-contrastereotype informatie om te kijken of er indicaties waren dat de neurale verwerking van genderstereotype en gender-contrastereotype informatie verschilde. Zowel bij ouders als bij volwassenen zonder kinderen werden neurale processen die gerelateerd zijn aan vroege visuele informatieverwerking sterker geactiveerd wanneer (onbekende) kinderen genderstereotype verwachtingen schonden, dan wanneer deze werden bevestigd. Bovendien waren er indicaties dat bij ouders de mate van activatie van deze hersenprocessen in reactie op genderstereotype informatie over hun *eigen* kinderen, gerelateerd was aan het gebruik van gender labels tijdens het voorlezen van een platenboek (ouderlijke gendersocialisatie). Tot slot is gebleken dat hersenprocessen die gericht zijn op het detecteren van opmerkelijke en relevante informatie ook betrokken zijn bij de verwerking van genderstereotype informatie, maar de richting verschilde voor ouders en volwassenen zonder kinderen. Waar bij ouders sprake was van meer hersenactivatie wanneer hun *eigen* kinderen genderstereotype verwachtingen schonden versus bevestigden, bleek dat volwassenen zonder kinderen een sterkere neurale reactie hadden op kinderen die genderstereotype verwachtingen bevestigden dan schonden.

De derde onderzoeksvraag had als doel om de relatie tussen gendertypisch probleemgedrag van het kind en ouderlijke gendersocialisatie te onderzoeken. In dit proefschrift is geen bewijs gevonden voor een relatie tussen internaliserend en externaliserend gedrag van zonen en dochters en ouderlijke gendersocialisatie.

Tot slot is onderzocht of de effecten van gendersocialisatie zichtbaar waren in de neurale verwerking van genderstereotype informatie bij driejarige kinderen. De resultaten van dit onderzoek toonden aan dat er indicaties waren dat driejarige kinderen sterkere neurale reacties met betrekking tot aandachtverwerking lieten zien wanneer ze foto's zagen van blije mannen dan wanneer ze foto's zagen van blije vrouwen. Daarnaast bleek dat hersenprocessen gericht op het detecteren van opmerkelijke en relevante informatie sterker werden geactiveerd wanneer driejarige kinderen blije gezichten van hetzelfde geslacht als zijzelf zagen dan wanneer deze kinderen blije gezichten zagen van een ander geslacht dan zijzelf.

Samenvattend toont dit proefschrift aan dat de mate waarin ouders genderstereotype verwachtingen hebben, evenals hun neurale processen die verband houden met aandachtverwerking, het detecteren van opmerkelijke en relevante informatie, conflictmonitoring en beloningsverwerking, mogelijk kunnen verklaren waarom sommige ouders geneigd zijn meer traditionele vormen van gendersocialisatie toe te passen, terwijl andere ouders streven naar gendergelijke opvoeding. Ouderlijke gendersocialisatie tijdens de vroege kindertijd kan belangrijke gevolgen hebben voor de genderontwikkeling van kinderen, bijvoorbeeld voor de ontwikkeling van genderstereotype verwachtingen op jonge leeftijd.

About the author

Christel Madeleine Portengen was born on October 15th 1992 in Valkenburg (Zuid-Holland), the Netherlands. She obtained her bachelor degree in Psychology from Tilburg University in 2017 in which she followed the Psychology and Health track. After obtaining her bachelor degree she continued her education with a master in Neuropsychology at Maastricht University. During her masters she spent time as a research intern at the Donders Institute for Brain, Cognition, and Behavior in Nijmegen. After her masters she continued to work there as a research assistant for several months, until she started her PhD project in September 2019 at the department of Clinical Child and Family Studies at Utrecht University. This PhD project has led to this dissertation. During her PhD, she spent three months in 2023 as a visiting scholar at the Methods, Sex differences, and Development lab at the University of Michigan in Ann Arbor.

Christel is continuing her work at the Methods, Sex differences, and Development lab as a post-doc on several projects, examining the effects of hormones on gender development, and the role of sex/gender and the brain in development across the lifespan.

Publication list

Published

Portengen, C. M., Junge, C., van Baar, A. L., & Endendijk, J. J. (2023). Women are expected to smile: The role of gender in the neurophysiological processing of adult emotional faces in 3-year-old children. *Developmental Psychobiology.* https://doi.org/10.1002/dev.22443

Riemens, A., **Portengen, C. M.,** & Endendijk, J. J. (2023). Associations between parental dispositional attributions, dismissing and coaching reactions to children's emotions, and children's problem behaviour moderated by child gender. *Cognition and Emotion*. https://doi.org/10.1080/02699931.2023.2214350

Endendijk, J. J., **Portengen, C. M.,** Verhoeven, M., & Huijding, J. (2023). Dutch mothers' and fathers' differential attributions and parenting reactions to the misbehavior of sons and daughters. *Psychology of Men and Masculinity*. https://doi.org/10.1037/men0000434

Antoniucci, C., **Portengen, C.M.,** & Endendijk, J. J. (2023). Like parent, like child: General and specific associations between parents' and children's binary gender identity in a gender egalitarian context. *Sex Roles*. https://doi.org/10.1007/s11199-023-01356-y

Portengen, C. M., van Baar, A. L., & Endendijk, J. J. (2023). A neurocognitive approach to studying processes underlying parents' gender socialization. *Frontiers in Psychology*. https://doi.org/10.3389/fpsyg.2022.1054886

Damatac, C. G., Soheili-Nezhad, S., Blazquez Freches, G., Zwiers, M. P., de Bruijn, S., Ikde, S., **Portengen, C. M.**, Abelmann, A. C., Dammers, J. T., van Rooij, D., Akkermans, S. E. A., Naaijen, J., Franke, B., Buitelaar, J. K., Beckmann, C. F., & Sprooten, E. (2022). Longitudinal changes of ADHD symptoms in association with white matter microstructure: A tract-specific fixel-based analysis. *NeuroImage: Clinical*. https://doi.org/10.1016/j.nicl.2022.103057

Portengen, C. M., Huffmeijer, R., van Baar, A. L., & Endendijk, J. J. (2022). Measuring the neural correlates of the violation of social expectations: A comparison of two experimental tasks. *Social Neuroscience*. https://doi.org/10.1080/17470919.2022.2032327

Endendijk, J. J., & **Portengen, C. M.** (2021). Children's views about their future career and family involvement. Associations with children's gender schemas and parents' involvement in work and family roles. *Frontiers in Psychology.* https://doi.org/10.3389/fpsyg.2021.789764

Portengen, C. M., Sprooten, E., Zwiers, M. P., Hoekstra, P. J., Dietrich, A., Holz, N. E., Aggensteiner, P. M., Banaschewski, T., Schulze, U. M. E., Saam, M. C., Craig, M. C., Sethi, A., Santosh, P., Ouriaghli, I., S., Castro-Fornieles, J., Arango, C., Penzol, M. J.,Werhahn, J. E., Brandeis, D., ... Naaijen, J. (2021). Reward and punishment sensitivity are associated with cross-disorder traits. *Psychiatry Research.* https://doi.org/10.1016/j.psychres.2021.113795

Work in progress

Endendijk, J. J., Antoniucci, C., Chadwick-Brown, F., Halim, M. L., & **Portengen, C. M.** Gender-typical appearance in early childhood: Roles of parental socialization and children's gender identity. *Under Review.*

Endendijk, J. J., & **Portengen, C. M.** Gender & gender roles in family relationships. In Nickola C. Overall, Jeffry A. Simpson, & Justin A. Lavner (Eds.) *Research Handbook on Couple and Family Relationships.*

Portengen, C. M., Harrewijn, A., van Baar, A. L., & Endendijk, J. J. Gender-differentiated emotion socialization: Evoked by child behaviors or driven by parents' neural responses toward gender-stereotype violations? *Under Review.*

Portengen, C. M., van Baar, A. L., & Endendijk, J. J. Mothers' and fathers' neural responses toward gender-stereotype violations by their own children. *Under Review.*

Yan, R., **Portengen, C. M.,** Chaku, N., Lopez-Duran, N., & Beltz, A. M. Adolescent-specific links between daily gender expression and daily depressive symptoms.