



# Hallucinations and other psychotic experiences across diagnoses: A comparison of phenomenological features

Maya J.L. Schutte<sup>a, #</sup>, Mascha M.J. Linszen<sup>a, #</sup>, Theresa M. Marschall<sup>a, \*</sup>, Dominic H. ffytche<sup>b</sup>, Sanne Koops<sup>c</sup>, Edwin van Dellen<sup>d</sup>, Sophie M. Heringa<sup>d</sup>, Arjen J.C. Slooter<sup>e</sup>, Rob Teunisse<sup>f</sup>, Odile A van den Heuvel<sup>g</sup>, Afina W. Lemstra<sup>h</sup>, Elisabeth M.J. Foncke<sup>h</sup>, Christina W. Slotema<sup>i</sup>, Joop de Jong<sup>j</sup>, Susan L. Rossell<sup>j</sup>, Iris E.C. Sommer<sup>a</sup>

<sup>a</sup> Department of Biomedical Sciences of Cells and Systems, University Medical Center Groningen, Groningen, the Netherlands

<sup>b</sup> Institute of Psychiatry, Psychology and Neuroscience, King's College London, London, UK

<sup>c</sup> Department of Neurology, University Medical Center Utrecht & Brain Center Rudolf Magnus, Utrecht, the Netherlands

<sup>d</sup> Department of Psychiatry, University Medical Center Utrecht & Brain Center Rudolf Magnus, Utrecht, the Netherlands

<sup>e</sup> Department of Intensive Care Medicine, Brain Center Rudolf Magnus, University Medical Center Utrecht, Utrecht, the Netherlands

<sup>f</sup> Department of Geriatric Psychiatry, Dementia, Dementia, Dementia, the Netherlands

<sup>g</sup> Department of Psychiatry and Department of Anatomy & Neurosciences, VU University Medical Center, Amsterdam, the Netherlands

<sup>h</sup> Department of Neurology, VU university medical center, Amsterdam, the Netherlands

<sup>i</sup> Parnassia Psychiatric Institute, The Hague, the Netherlands

<sup>j</sup> Centre for Mental Health, Swinburne University & Voices Clinic, Monash Alfred Psychiatry Research Centre, Melbourne, Australia

## ARTICLE INFO

### Keywords:

Questionnaire for psychotic experiences (QPE)

Hallucinations

Voices

Transdiagnostic

Phenomenology

Major psychiatric disorders

Neurodegenerative disorders

Sensory impairment

## ABSTRACT

Although psychotic experiences are prevalent across many psychiatric, neurological, and medical disorders, investigation of these symptoms has largely been restricted to diagnostic categories. This study aims to examine phenomenological similarities and differences across a range of diagnoses.

We assessed frequency, severity and phenomenology of psychotic experiences in 350 outpatients including: participants with schizophrenia spectrum disorders, hearing impairment, Parkinson's disease, Lewy Body Dementia, Alzheimer's disease, visual impairment, posttraumatic stress disorder, borderline personality disorder, and participants with recent major surgery. Psychotic phenomena were explored between these groups using the Questionnaire for Psychotic Experiences (QPE).

Participants with major psychiatric disorders reported a combination of several psychotic experiences, and more severe experiences compared to all other disorders. Participants with recent major surgery or visual impairment experienced isolated visual hallucinations. Participants with hearing impairment reported isolated auditory hallucinations, whereas the neurodegenerative disorders reported visual hallucinations, occasionally in combination with hallucinations in another modality or delusions. The phenomenology between neurodegenerative disorders, and within major psychiatric disorders showed many similarities.

Our findings indicate that the phenomenology of psychotic experiences is not diagnosis specific, but may rather point to the existence of various subtypes across diagnoses. These subtypes could have a different underlying etiology requiring specific treatment.

## 1. Introduction

Psychotic experiences are highly prevalent in patients with many types of psychiatric and neurological disorders and other medical diseases (Sommer et al., 2012). These psychotic experiences are not necessarily a hallmark for psychosis, and reality testing may be intact,

especially those with isolated hallucinations in one modality. In combination, hallucinations and delusional ideas can cause severe behavioral disturbances which complicates the care for these patients, especially by non-professional caregivers.

Hallucinations and delusions commonly occur in schizophrenia, with prevalence rates of 59% for hallucinations and 73% of delusions

\* Corresponding author.

E-mail address: [t.m.marschall@umcg.nl](mailto:t.m.marschall@umcg.nl) (T.M. Marschall).

# These authors contributed equally to this work.

<https://doi.org/10.1016/j.psychres.2020.113314>

Received 21 February 2020; Received in revised form 15 July 2020; Accepted 19 July 2020

Available online 22 July 2020

0165-1781/ © 2020 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

(Lecrubier et al., 2007), often complicated by decreased reality testing. Mild psychotic experiences also occur in 60% of the patients with Parkinson's disease (Forsaa et al., 2010), 50% of the patients with posttraumatic stress disorder (PTSD) (Anketell et al., 2010) and borderline personality disorder (Kingdon et al., 2010), followed by 43–86% in delirium (Perälä et al., 2010), 11–62% in bipolar disorder (Toh et al., 2015), 25–78% in dementia with Lewy bodies (Nagahama et al., 2007), 5–40% in unipolar depression (Toh et al., 2015), 16% in hearing impairment (Linszen et al., 2019) and 11% in visual impairment (Teunisse et al., 1995). Symptoms and severity differ largely both within and between different diagnostic groups, but similarities are also seen. For example, many patients (with either schizophrenia, borderline personality disorder, Parkinson's disease or dementia) see scary faces when the sun is setting and respond upset to this experience.

Auditory hallucinations and delusional perceptions have been extensively investigated in the context of schizophrenia spectrum disorders, suggesting these experiences to be specifically related to this disorder. However, recent evidence suggests that these experiences could be seen as transdiagnostic phenomena (Llorca et al., 2016). For example, hallucinations in bipolar disorder are known to occur in both the manic and depressive episodes (Black and Nasrallah, 1989; Goodwin et al., 2007), and have similar phenomenology as in schizophrenia, such as negative voices, and persecutory delusions (Toh et al., 2015). Some controversy exists as to whether hallucinations in borderline personality disorder are similar to those in seen psychosis. Traditionally, these hallucinations are deemed pseudo-hallucinations, because insight into the hallucinations is often intact (Hepworth et al., 2013). However, more recent studies suggest auditory hallucinations to be phenomenologically similar in both borderline personality disorder and schizophrenia (Slotema et al., 2012). The same controversy exists for hallucinations in posttraumatic stress disorder for which phenomenological details are still elusive and have yet to be investigated. A transdiagnostic comparison of hallucinations and delusions in these disorders could help elucidate this controversy.

Hallucinations and delusions in neurological disorders have mostly been researched in the context of Parkinson's disease and dementia with Lewy bodies, two disorders in which hallucinations and delusions show many similarities in phenomenology (Aarsland et al., 2001). Psychotic experiences include visual hallucinations, which are typically animals, people, or objects (Aarsland et al., 2001; Barnes and David, 2001), and in later stages of the disease, delusions and hallucinations in other modalities (Ffytche et al., 2017; McKeith et al., 2004). Delusions of persecution are among the most prevalent psychotic experiences reported in patients with Alzheimer's disease (AD) and often occur early in the disease (Bassiony et al., 2000; Bassiony and Lyketsos, 2003). These persecutory delusions can relate to theft, infidelity or abandonment (Reeves et al., 2012). Hallucinations in Alzheimer's disease are mainly visual or auditory, but hallucinations in other modalities have also been reported (Bassiony and Lyketsos, 2003).

Hallucinations are not unique to psychiatric or neurodegenerative disorders, but also occur in patients with sensory impairment. Hallucinations in these patients are often considered transient, without need for treatment, but could also have a negative outcome with clinical implications (Cox and Ffytche, 2014). Patients with hearing impairment typically experience auditory hallucinations, including non-verbal sounds, musical hallucinations, but also voices (Linszen et al., 2019; Teunisse and Rikkert, 2012). Patients with visual impairment can experience hallucinations of patterns, faces, objects, figures and animals (Jurišić et al., 2018).

As of yet, psychotic experiences are researched within their own diagnosis; comparisons of phenomenology across the boundaries of psychiatric and neurological disorders are scant. Changing the perspective from a diagnosis-based to a more symptom-based approach, in line with RDoC (Insel et al., 2010), would facilitate comparison of psychotic experiences across diagnoses and may point to shared or

different mechanisms underlying these experiences.

Llorca et al. (2016) recently made a first transdiagnostic comparison of hallucinations between patients with schizophrenia and Parkinson's disease. A combination of auditory and visual hallucination was most common for both groups, whereas hallucinations in schizophrenia were more severe on any other phenomenological aspect (e.g. frequency, duration, negative aspects, conviction, etc.).

This study intends to examine the similarities and differences of psychotic experiences in a wide range of disorders, including clinical and non-clinical psychotic experiences. The aim is two-fold; first, psychotic experiences in psychiatric and neurological disorders will be compared across diagnoses *within* their specialism. We hypothesize these hallucinations to be highly similar. Second, we will compare presence and phenomenology of psychotic experiences between the following five categories; 1) the major psychiatric disorders; 2) neurodegenerative disorders; 3) conditions after recent major surgery; 4) hearing impairment and 5) visual impairment. We hypothesize to find important differences across these larger groups. Investigating hallucinations and delusions regardless of diagnosis can enrich our understanding of etiology and treatment needs, and could elucidate possible subtypes of psychotic experiences across disorders.

## 2. Methods

### 2.1. Participants

Participants were recruited from the departments of psychiatry, audiology, ophthalmology, and intensive care unit (ICU) of the University Medical Center Utrecht (UMCU), from psychiatry and neurology departments of the VU university medical center in Amsterdam (VUmc), and from the psychiatric institute PsyQ in The Hague.

Inclusion criteria were; 1) at least  $\geq 18$  years of age; and 2) experienced hallucinations and/or delusions in the past month. All participants had to speak or understand the Dutch language and had to be mentally competent as judged by the treating physician. All participants provided written informed consent. The study was approved by the UMCU institutional review board (protocol NL42959.041.13) and was in accordance with the Declaration of Helsinki.

### 2.2. Procedures

Participants were selected and approached via their treating physician and were only included in the current study when they experienced hallucinations or delusions in the last month. Using key questions of the QPE, the presence of hallucinations and delusions was assessed. Participants who scored positive on the screening were subsequently administered the full QPE assessing psychotic experiences in the preceding week. Participants who did not experience hallucinations or delusions in the last week, but did experience this in the last month, were also included in the study. In such cases, the QPE was used to assess experiences in the last month. Recent major surgery patients were screened for hallucinations on four consecutive postoperative days, assessing experiences in the preceding day. Procedures were identical at all sites. The Mini-Mental State Examination (MMSE; Folstein et al., 1975) was used to assess the participants' cognitive state. Age, gender and education level were also recorded.

### 2.3. Assessment of psychotic experiences

We assessed psychotic experiences using the QPE. The QPE is a questionnaire consisting of 50 items that is designed to quantify range of psychotic experiences, focusing on hallucinations and delusions (Sommer et al., 2018). In contrast to clinical scales such as the Brief Psychiatric Rating Scale (BPRS; Overall and Gorham, 1962), the Neuropsychiatric Inventory (NPI; Cummings et al., 1994) and the Positive and Negative Symptom Scale (PANSS; Kay et al., 1987), this

questionnaire not only inquires after problematic and stressful psychotic symptoms, but covers the entire spectrum of psychotic experiences, including misinterpretations, visual illusions, halo seeing/phenomena, incubus and other sleep-related phenomena, sensed presence, passage hallucinations and visions, etc. (Blom, 2010). For this questionnaire hallucination were defined as a perception without a clear source from the environment. There are more complex definitions, for example stating that hallucinations proper should occur with full consciousness, or that hallucinations proper should not have good insight (Waters et al., 2016). These extra definitions were not applied when developing the QPE, making the QPE highly suitable to assess the full spectrum of hallucinations, delusions and psychotic-like experiences of any origin and any duration. The QPE has also proven itself to be a successful tool to investigate the link between psychotic experiences and other disorders such as atopic disorders (Begemann et al., 2019). Likewise, the QPE has been employed in a large-scale study of hallucinations in the general Dutch population during which a relationship between psychotic experiences and processes of auditory language perception (de Boer et al., 2019).

The QPE consists of 50 items categorized into four subscales; Auditory Hallucinations (A); Visual Hallucinations (V); Hallucinations in Other modalities (O); and Delusions (D). The QPE was developed to include the most important psychotic experiences covering all disorders, including auditory, visual, olfactory and tactile hallucinations, sensed presence, illusions, delusional ideation, and delusions. The development and validation of the QPE is further described in Rossell et al. (2019).

## 2.4. Statistical analysis

A similar approach as in (Llorca et al., 2016) was applied to compare phenomenological features of hallucinations. First, a non-parametric Kruskal-Wallis one-way ANOVA test was used to examine similarities and differences in phenomenology *within* the categories of major psychiatric and neurodegenerative disorders. Mann-Whitney *U* tests were used for post-hoc analyses. Secondly, to facilitate comparison of psychotic experiences across diagnoses, all participants were subdivided over five categories; 1) major psychiatric disorders; 2) neurodegenerative disorders; 3) recent major surgery; 4) hearing impairment; 5) visual impairment, as presented in Table 1. A Venn diagram was used to examine differences in symptomatology across these categories. Differences in categorical data were tested with a  $\chi^2$  test or Fisher's

exact test. Statistical analyses were conducted in SPSS (version 24.0) and R-software (version 1.0.136) (<https://www.r-project.org/>). To correct for multiple testing, results are reported with a Bonferroni correction.

## 3. Results

### 3.1. Participants

A total of 350 participants were administered a QPE, including patients with a confirmed diagnosis of a) schizophrenia spectrum disorder; b) mood disorder; c) post-traumatic stress disorder; d) borderline personality disorder; e) Parkinson's disease; f) dementia with Lewy bodies; g) Alzheimer's disease; h) recent major surgery; i) visual impairment (visual acuity < 0.5 in both eyes); and j) hearing impairment in at least one ear (defined as High Fletcher Index > 25 dB; mean of hearing thresholds at 1000/2000/4000 Hz; as measured by calibrated, pure tone audiometry). Some recent major surgery patients fulfilled criteria for delirium (i.e. had a positive Confusion Assessment Measure score (CAM-ICU; Ely et al., 2001) or clear indications for delirium present in medical record) 4 days post operation, and others experienced hallucinations in a non-delirious state. See Table 1 for participant characteristics. The average MMSE score in the neurodegenerative group was 24 (range 11–30). The QPE was scored with additional information of an informant in the few participants ( $n = 3$ ) in the neurodegenerative group with a low MMSE score (< 20).

### 3.2. Phenomenological comparison within the major psychiatric category

Phenomenological aspects of auditory and visual hallucinations were compared between participants with a schizophrenia spectrum, borderline personality disorder, posttraumatic stress disorder and mood disorder. As is presented in the upper row of Fig. 1, most hallucinatory features were highly similar between the groups. Frequency (Kruskal-Wallis *H* test:  $H[3] = 11.7$ ;  $p = .008$ ) and duration ( $H[3] = 10.5$ ;  $p = .015$ ) of the auditory hallucinations significantly differed between groups. Post-hoc tests indicated that patients with posttraumatic stress disorder experienced auditory hallucinations less often ( $p = .040$ , adjusted for multiple testing), and with a shorter duration than patients with schizophrenia ( $p = .016$ , adjusted for multiple testing). The characteristics of visual hallucinations were not significantly different between the four groups ( $H[3] \leq 5.28$ ;  $p \geq .152$  for all).

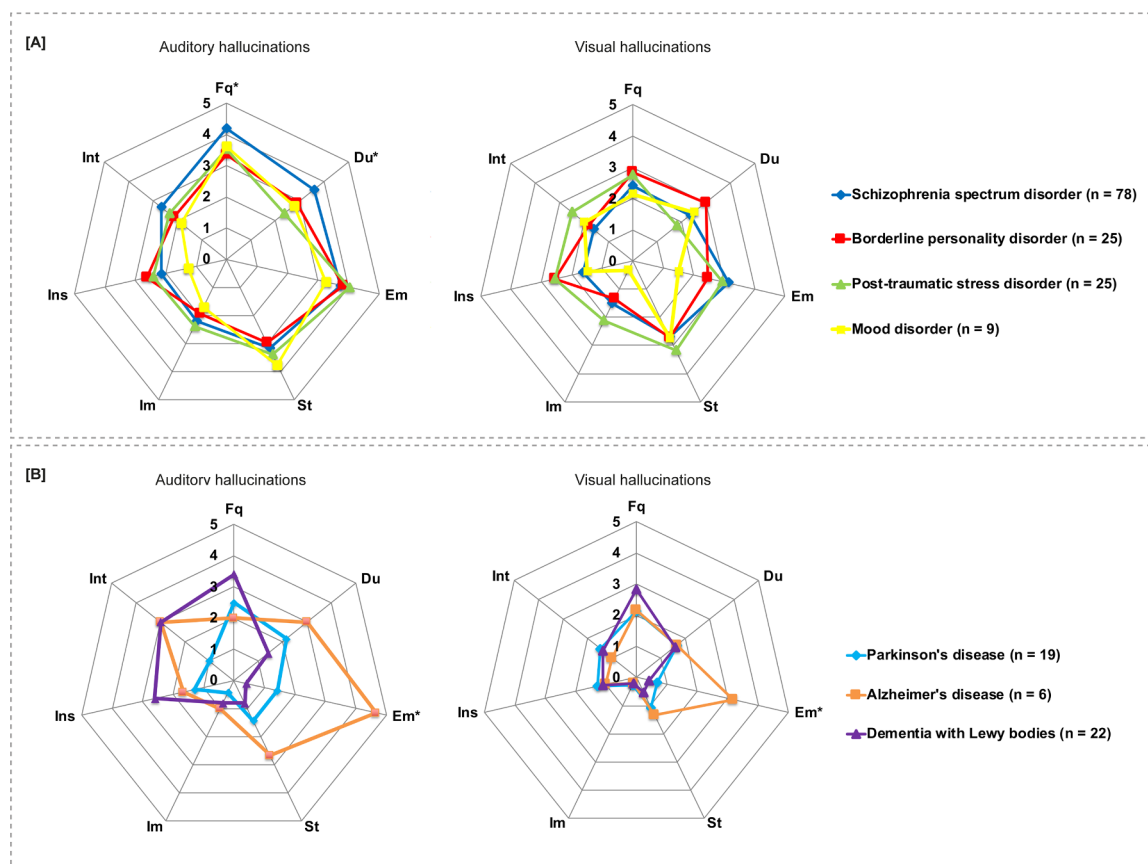
**Table 1**

Participant characteristics of the total sample ( $n = 350$ ).

Disorder	n	Age M (SD)	Education M (SD)	Gender Females%	Total MMSE M (SD)
<b>Major psychiatric disorders</b>	<b>137</b>				
Schizophrenia spectrum disorder	78	39.9 (13.9)	4.3 (2.0)	44.9	27.6 (2.0)
Mood disorder	9	43.7 (17.1)	5.5 (1.8)	55.6	28.5 (1.4)
Borderline personality disorder	25	42.5 (13.7)	3.3 (0.5)	100	-
Post-traumatic stress disorder	25	44.7 (9.4)	3.6 (2.1)	84.0	26.3 (4.0)
<b>Neurodegenerative disorders</b>	<b>47</b>				
Dementia with Lewy bodies	22	69.4 (5.5)	5.1 (2.0)	9.1	23.3 (5.4)
Parkinson's disease	19	68.7 (8.2)	5.3 (1.8)	52.6	26.2 (4.8)
Alzheimer's disease	6	69.5 (9.6)	5.3 (1.8)	33.3	23.8 (2.4)
<b>Recent major surgery</b>	<b>60</b>				
No - delirium	46	68.5 (9.3)	5.4 (2.3)	32.6	28.0 (2.7)
Delirium	14	71.5 (7.3)	4.9 (2.5)	21.4	27.6 (2.4)
<b>Hearing impairment</b>	<b>87</b>	56.6 (14.6)	5.5 (1.9)	50.6	28.7 (1.6)
<b>Visual impairment</b>	<b>19</b>	76.3 (12.5)	4.8 (1.9)	52.6	28.6 (3.6)

Education is assessed by applying Verhage system (7 categories; Verhage, 1964).

Abbreviations: M mean; MMSE Mini-Mental State Examination; SD Standard Deviation.



**Fig. 1.** Phenomenology of auditory and visual hallucinations in the major psychiatric and neurodegenerative disorders. The upper row compares the four psychiatric disorders on frequency (Fq), duration (Du), emotional valence (Em), distress (St), impact on functioning (Im), interaction (Int) and insight (Ins). The mean of the presented QPE items was calculated for each group and presented in the spider webs, with 0–5 the range of possible scores. A higher score on insight (Ins) indicates less preserved insight. The four groups showed significant differences for auditory hallucinations on frequency and duration (\* Bonferroni corrected for 7 tests at  $p < .05/7$ ).

### 3.3. Phenomenological comparison within the neurodegenerative category

A comparison of auditory and visual hallucinations in patients with Parkinson's disease, dementia with Lewy bodies and Alzheimer's disease is displayed in the lower row of Fig. 1. Significant differences were found between emotional valence of the auditory and visual hallucinations between the three groups (auditory  $H[2] = 6.6$ ;  $p = .037$ ; visual  $H[2] = 6.3$ ;  $p = .042$ ). Post-hoc tests revealed that the emotional valence was more severe (i.e. content was more often negative) in participants with Alzheimer's disease versus participants with dementia with Lewy bodies for both auditory and visual hallucinations (auditory  $p = .038$  visual  $p = .035$ ; both adjusted for multiple testing).

### 3.4. Presence of psychotic experiences across all categories

The presence of hallucinations and delusions per category are presented in Table 2. The neurodegenerative (87.2%), recent major surgery (95.0%) and visual impairment (94.7%) categories were predominantly characterized by visual hallucinations. Few of these patients endorsed on other symptoms, although a substantial proportion of the patients with a neurodegenerative disorder also experienced delusions (21.3%; see Table 2). Patients with hearing impairment all experienced auditory hallucinations (100%), as well as patients with a major psychiatric disorder (93.4%). Most of the participants with a major psychiatric disorder typically experienced multiple psychotic experiences, such as auditory hallucinations in combination with visual hallucinations. As presented in the Venn diagram of Fig. 2, isolated auditory hallucinations occurred in 11.7% of the patients with a major

psychiatric disorder. Isolated visual, tactile or olfactory hallucinations were far less common in this group, and rather co-occurred with hallucinations in other modalities or delusions. Of all participants with a major psychiatric disorder, a total of 14.6% endorsed on all five symptoms (auditory, visual, tactile, olfactory hallucinations and delusions), which was uncommon in all other diagnostic categories.

For other categories of symptoms presented in Table 2, sensed presence was experienced most often in participants with a major psychiatric disorder (39.3%), followed by patients with visual impairment (21.4%) and a neurodegenerative disorder (19.1%). Visual illusions were most common in the neurodegenerative category (46.8%), followed by visual impairment (31.6%) and patients with a major psychiatric disorder (21.2%). The number of hallucinations that were endorsed by each category significantly differed, as well as the number of delusions (see Table 2). The proportion of participants with a major psychiatric disorder experiencing more than one type of hallucination, or more than one type of delusion, was higher than in the other groups. Delusions were most frequent in the major psychiatry category (51.1%), and least frequent in participants with recent major surgery (5.0%). Paranoid delusions were most often present in patients with a major psychiatric disorder (34.0%), as well as in neurodegenerative disorders (8.5%). A detailed overview of the different delusional themes reported in the various disorders can be found in the Supplementary Table 1.

#### 3.4.1. Comparison of phenomenology of auditory and visual hallucinations across all categories

The phenomenological characteristics of auditory and visual hallucinations were subsequently compared between all five major



**Table 2**  
The presence of psychotic experiences and symptoms profiles per category.

	Major psychiatric disorders (%)	Neurodegenerative disorders (%)	Recent major surgery (%)	Hearing impairment (%)	Visual impairment (%)	p	Post-hoc
Auditory hallucinations	(n = 137) 93.4	(n = 47) 36.2	(n = 60) 10.0	(n = 87) 100	(n = 19) 31.6	< 0.001	RS < ND = VI < P < HI
Visual hallucinations	65.1	87.8	95.0	15.3	94.7	< 0.001	HI < P < RS = ND = VI
Tactile hallucinations	50.8	12.8	6.7	16.3	10.5	< 0.001	RS = ND = VI = HI < P
Olfactory hallucinations	53.0	14.9	3.6	12.3	11.1	< 0.001	RS = ND = VI = HI < P
Sensed presence hallucination	39.3	19.1	7.4	6.3	21.4	< 0.001	RS = ND = VI = HI < P; P = VI
Visual illusions	21.2	46.8	10.0	2.3	31.6	< 0.001	HI < ND = RS = VI = P; P < ND
Delusions	51.1	21.3	5.0	12.6	10.5	< 0.001	RS < VI = HI = ND < P; RS < ND
Hallucinations in multiple modalities <sup>a</sup>	77.7	38.3	10.7	30.7	33.4	< 0.001	RS < VI = ND = HI < P
Multiple delusional themes <sup>b</sup>	26.6	6.4	0.0	3.5	0.0	< 0.001	RS = ND = VI = HI < P

All items were scored as presence (yes/no) and differences were tested with Fisher's exact test or  $\chi^2$  test. Significant differences ( $p < .005$ , Bonferroni corrected) are printed in bold. Abbreviations: HI hearing impairment; ND neurodegenerative disorders; P major psychiatric disorders; RS recent major surgery; VI visual impairment.

<sup>a</sup> Positively scored when more than one hallucination was present. Bonferroni corrected for 9 tests (0.05/9 = 0.005).

<sup>b</sup> Multiple delusional themes were positively scored when participants endorsed on two or more delusions or delusional ideat.

categories. An evaluation of auditory and visual hallucinations is presented in a Venn diagram of Fig. 3. All phenomenological aspects, including frequency (Fq), duration (Du), emotional valence (Emo), distress (St), impact on functioning (Im), interaction with the hallucinations (Int), and insight into the hallucinations (Ins) were significantly higher in the category major psychiatric disorders compared to the other groups, including for auditory ( $H[2] \geq 12.4$ ;  $p \leq .002$  for all) and visual hallucinations ( $H[3] \geq 35.4$ ;  $p \leq .001$  for all). Frequency of visual hallucinations ( $H[3] = 4.82$ ;  $p = .185$ ) and duration of visual hallucinations ( $H[3] = 7.46$ ;  $p = .059$ ) did not differ across categories.

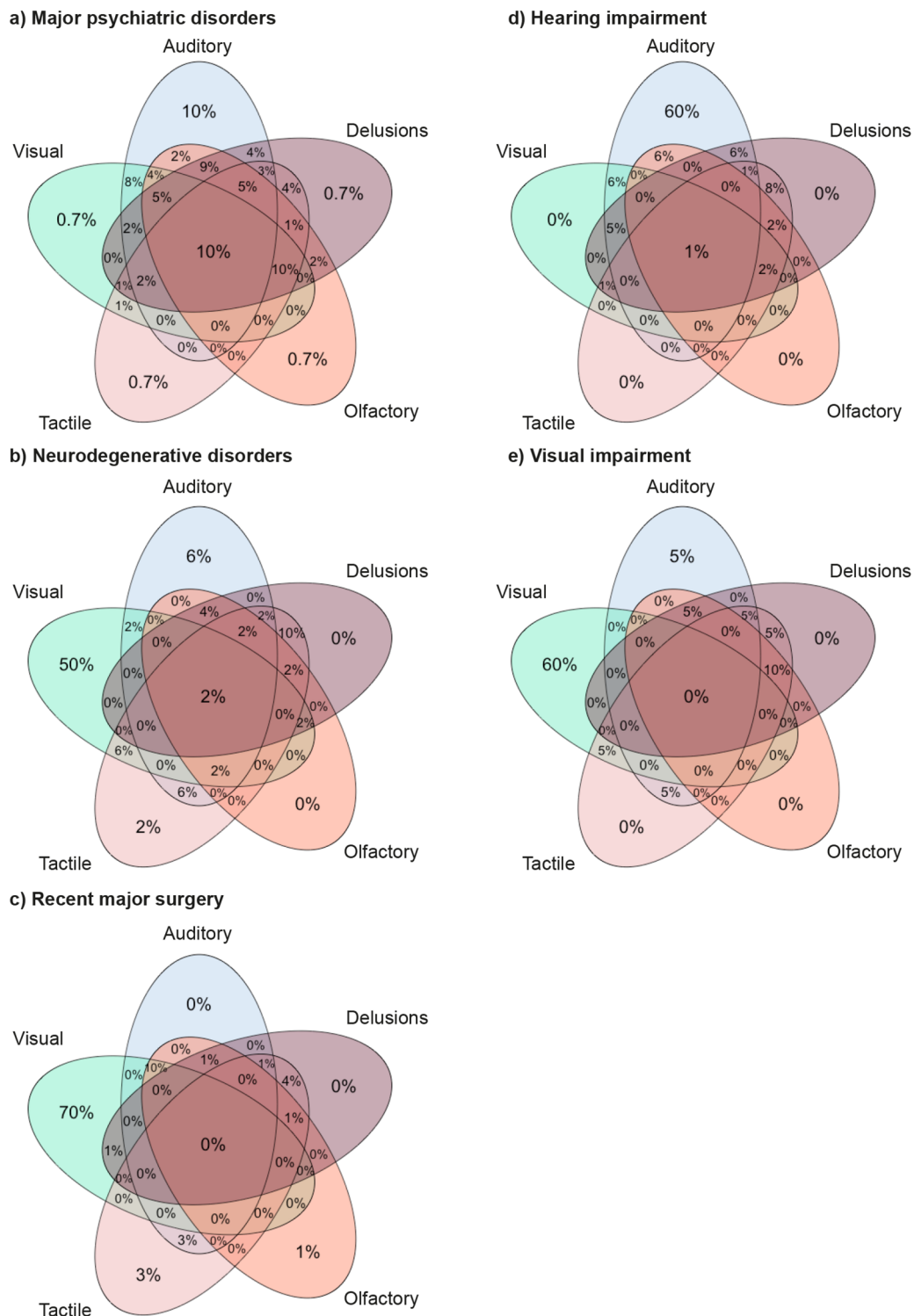
Post-hoc analyses compared all phenomenological features between the different diagnostic groups. For auditory hallucinations, the most notable differences were observed between psychiatric disorders versus hearing impairment and neurodegenerative disorders. For hearing impairment, all phenomenological aspects were significantly different, with patients with hearing impairment scoring lower on all items compared to patients with a major psychiatric disorder ( $p \leq .001$  for all, corrected for multiple testing). The psychiatric and neurodegenerative group did not differ on insight into the auditory hallucinations ( $p = .673$ , corrected for multiple testing), but frequency, duration, emotional valence, distress, impact on functioning and interaction were all less severe in neurodegenerative disorders compared to patients with a psychiatric disorder ( $p \leq .001$  for all, corrected for multiple testing). The phenomenology of auditory hallucinations did not differ between participants with hearing impairment and neurodegenerative disorders ( $p = 1.00$  for all, corrected for multiple testing), except that participants with hearing impairment had more preserved insight in their auditory hallucinations ( $p = .006$ , corrected for multiple testing) compared participants with to neurodegenerative disorders.

For visual hallucinations, the most notable finding was that patients with a neurodegenerative disorder and visual impairment did not differ on any of the phenomenological items ( $p \geq .946$  for all, corrected for multiple testing). Neither did the visual impairment and recent major surgery groups ( $p \geq .609$  for all, corrected for multiple testing). Participants with a neurodegenerative disorder had less interaction with the visual hallucinations compared to participants with a recent major surgery ( $p = .002$ , corrected for multiple testing). Participants with visual impairment and recent major surgery scored significantly lower on emotional valence, distress, impact on functioning, interaction and insight into the hallucinations as compared to participants with a major psychiatric disorder ( $p \leq .035$  for all, corrected for multiple testing), except that participants with visual impairment did not differ from participants with a psychiatric disorder on insight into realness of the hallucinations ( $p = .070$  corrected for multiple testing). Participants with a neurodegenerative disorder scored significantly lower on emotional valence, distress, impact on functioning and insight (i.e. meaning more insight into their hallucinations) compared to participants with a major psychiatric disorder ( $p \leq .016$  for all, corrected for multiple testing), but did not differ on interaction with the hallucinations ( $p = .572$ , corrected for multiple testing).

#### 4. Discussion

This study provides a phenomenological comparison of psychotic experiences in 350 participants with a wide range of disorders. The Questionnaire for Psychotic Experiences (QPE) was developed to facilitate a transdiagnostic comparison of these psychotic experiences, as it includes symptoms that are usually assessed in a particular disorder only (for example, sensed presence in neurodegenerative disorders). Participants in this sample all endorsed psychotic experiences in the last month, which allowed us to explore differences and similarities in phenomenological features between a variety of diagnostic groups.

A comparison of the phenomenology of psychotic symptoms within the major psychiatric category indicated that auditory and visual hallucinations were largely similar in phenomenology in participants with

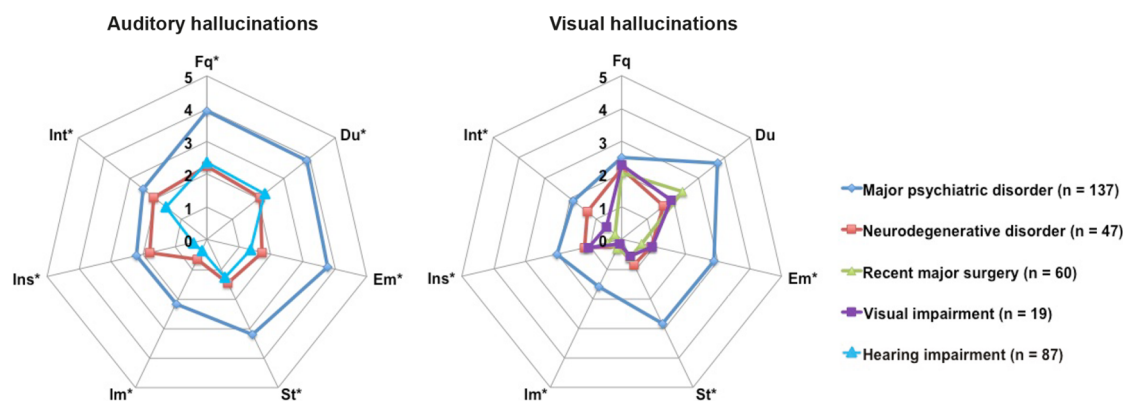


**Fig. 2.** Presence of hallucinations in four modalities across all five diagnostic categories in patients that experienced psychotic symptoms within the last month. The Venn diagrams show the percentages of isolated and overlapping symptom profiles in all five diagnostic categories. The overlap between two or more circles, meaning the interaction of two or more sets, indicates that a percentage of the participants experienced a combination of these symptoms.

borderline personality disorder, posttraumatic stress disorder, mood disorder, and a schizophrenia spectrum disorder, suggesting that hallucinations in other psychiatric disorders can be just as frequent and distressing as in a primary psychotic disorder. Psychotic experiences within the neurodegenerative disorders were also largely identical. Participants with Parkinson's disease and dementia with Lewy bodies did not differ in phenomenology. Also, exploratory analysis in

participants with Alzheimer's disease pointed towards similar psychotic experiences as in the other neurodegenerative disorders.

Whereas large similarities were seen within specific disease domains, differences were observed across domains. Our results suggest that participants with a major psychiatric disorder such as schizophrenia, posttraumatic stress disorder and borderline personality disorder can experience isolated auditory hallucinations, but more often



**Fig. 3.** Phenomenological comparison of auditory and visual hallucinations across all five diagnostic categories. The mean of the presented QPE items was calculated for each group and presented in the spider webs, with 0–5 the range of possible scores. A higher score on insight (Ins) indicates less preserved insight. Significant differences ( $p < .05$ ) are indicated by an asterisk (\*). Abbreviations: Fq frequency, Du duration, Em emotional valence, St stress, Im impact, Ins insight, Int interaction.

experience a diffuse set of hallucinations in different modalities co-occurring with delusions. This contrasts with findings in ICU participants with recent major surgery, and in those with hearing or visual impairment, who merely experienced isolated hallucinations in one modality (e.g. auditory or visual hallucinations) without comorbid hallucinations. The majority of participants with hearing and visual impairment did not endorse delusions, and often had preserved insight in their hallucinations. This could be of additional value in discriminating between hallucinations due to neurodegenerative disorders versus hearing or visual impairment, as a larger proportion of the participants with neurodegenerative diseases did also endorse delusions. Also, it is known from the literature that sensed presence is a common symptom for Parkinson's disease (Fénelon et al., 2011), but this symptom is rarely assessed in psychiatric disorders. Our results show that sensed presence was mainly experienced by participants with a major psychiatric disorder (39.3%), neurodegenerative disorders (19.1%) and in participants with visual impairment (21.4%). Visual illusions were most frequent in neurodegenerative disorders, but also in participants with visual impairment, which makes it difficult to discriminate between these disorders based on this symptom. In contrast, our results suggest that the co-presence of delusions, especially Cotard's and Capgras' syndrome, are more indicative of a neurodegenerative disorder than of visual impairment. Delusions were most common in schizophrenia spectrum disorders (51%), followed by the neurodegenerative group (21.3%). In both groups, paranoid themed delusions or delusional ideas were endorsed most frequently. Delusions of misidentification (Capgras syndrome) and nihilism (Cotard's syndrome) were endorsed by both schizophrenia and neurodegenerative disorders.

Taken together, this study investigated similarities and differences in psychotic experiences across a wide range of disorders. The results indicate that psychotic experiences are not specific for a particular diagnosis (i.e. schizophrenia) or group of diagnoses (major psychiatric disorders), but should be seen as transdiagnostic experiences. We observed prominent differences in phenomenology across the larger diagnostic categories (psychiatric, neurodegenerative, post-surgery and sensory impairment), such clear differences in phenomenology could suggest a different mechanism underlying the psychotic experiences in these groups. On the other hand, we found striking similarities within these larger categories, suggesting that participants with the same phenomenological subtype of psychotic experiences (for example those with schizophrenia, borderline personality and posttraumatic stress disorder) may have a shared underlying neural mechanism, although this hypothesis is in need of verification.

The need for a transdiagnostic tool was emphasized by the wide variety of psychotic experiences presented per disorder. Use of this general questionnaire provided a more complete overview of psychotic

experiences across disorders, facilitating symptom-focused research following RDoC criteria (Insel et al., 2010). A complete overview of psychotic experiences could help establish the presence of possible risk factors for later development of psychosis, leading to the implementation of early prevention strategies. Hallucinations or delusions experienced in isolation could be predictive of psychosis, although the odds ratio tends to be low (Daalman et al., 2016; Poulton et al., 2000). However, when more psychotic experiences are present (i.e., auditory hallucinations accompanied by reduced reality testing and loss of insight) the risk of full-blown psychosis rises (Askenazy et al., 2007; Daalman et al., 2016, 2011; Kaymaz and van Os, 2010; Krabbendam et al., 2004). As such, our results indicate that the presence of psychotic experiences per se are not indicative of psychosis, but that a multitude of psychotic experiences in combination with lack of insight or decreased reality testing should be at the center of attention.

Our results confirm previous findings that similar phenomena can exist across disorders (Daalman et al., 2011; Larøi et al., 2012; Llorca et al., 2016; McCarthy-Jones et al., 2014; Slotema et al., 2012). In line with the study of Aarsland et al. (2001), our results revealed that psychotic experiences in dementia with Lewy bodies and Parkinson's disease were highly similar. Paranoid delusion was the most common delusion reported by participants with a neurodegenerative disorder in our study, which is similar to previous studies (Aarsland et al., 2001; Chou et al., 2005; Reeves et al., 2012). Furthermore, Llorca et al. (2016) showed that 46% of the schizophrenia patients also experience sensed presence. In line with their study, sensed presence was also endorsed in major psychiatric disorders (39.3%) and in participants with visual impairment (21.4%), suggesting that this symptom is not as specific for neurodegenerative disorders as was previously thought. The high rate of participants with a major psychiatric disorder who experienced multiple symptoms is consistent with the previous findings of Llorca et al. (2016) comparing psychotic experiences in schizophrenia and Parkinson's disease.

The findings of this study should be interpreted in light of some limitations. Our participants were all outpatients and differ from unselected community-based patients; generalizability of our findings to more severely affected inpatients should be done with care. For example, the patients with schizophrenia had relatively preserved insight into the unreal character of their hallucinations, which might differ from severely affected inpatients. While this selection might not represent more severe cases, it could be a good reflection of patients' experiences outside of a clinical setting increasing the external validity of the study. Since only the most severely affected cases require inpatient care this sample portrays more widespread aspects of psychotic experiences. Furthermore, it should be taken into consideration that the

statistical power to detect differences between features of auditory and visual hallucinations *within* the psychiatric and neurodegenerative categories was limited due to relatively small samples. The groups of participants with Alzheimer's disease and with a mood disorders were particularly small, and should thus be viewed as exploratory findings. Similarities in psychotic symptoms with Alzheimer's disease need to be verified in larger samples, as previous studies indicate that delusions are the most frequently reported psychotic symptoms in Alzheimer's disease (Bassiony et al., 2000), whereas visual hallucinations are most common for Parkinson's and dementia with Lewy bodies (Barnes and David, 2001). Nonetheless, our results were in line with other studies comparing these diagnoses within their specialism, strengthening our finding that the phenomenology between schizophrenia, borderline personality disorder and post-traumatic stress disorder show many similarities (Slotema et al., 2012), as well as in dementia with Lewy bodies and Parkinson's disease (Aarsland et al., 2001).

#### 4.1. Conclusions

The results of this study indicate that for psychiatric disorders, more than one psychotic experience is generally present, and that the phenomenology of psychotic experiences in schizophrenia, posttraumatic stress disorder and borderline personality disorder are largely similar. For neurodegenerative disorders, visual hallucinations are predominant, but hallucinations in other modalities and delusions commonly co-occur. Participants with Parkinson's disease, dementia with Lewy bodies and Alzheimer's disease also had psychotic experiences largely similar in phenomenology. In ICU patients with recent major surgery, as well as in participants with sensory impairment, hallucinations were typically mono-modal and delusions were absent. This suggests the existence of several subtypes of psychotic experiences that occur across diagnostic groups. Investigating hallucinations and delusions regardless of diagnosis can enrich our understanding of etiology and treatment needs, and shed light on possible subtypes of psychotic experiences.

#### CRedit authorship contribution statement

**Maya J.L. Schutte:** Investigation, Formal analysis, Writing - original draft. **Mascha M.J. Linszen:** Methodology, Investigation, Project administration, Formal analysis. **Theresa M. Marschall:** Writing - review & editing, Visualization. **Dominic H. ffytche:** Writing - review & editing. **Sanne Koops:** Investigation, Writing - review & editing. **Edwin van Dellen:** Writing - review & editing. **Sophie M. Heringa:** Investigation, Project administration, Writing - review & editing. **Arjen J.C. Slooter:** Conceptualization, Methodology, Investigation, Writing - review & editing. **Rob Teunisse:** Conceptualization, Writing - review & editing. **Odile A van den Heuvel:** Conceptualization, Writing - review & editing. **Afina W. Lemstra:** Conceptualization, Writing - review & editing. **Elisabeth M.J. Foncke:** Conceptualization, Writing - review & editing. **Christina W. Slotema:** Investigation, Writing - review & editing. **Joop de Jong:** Investigation, Writing - review & editing. **Susan L. Rossell:** Conceptualization, Methodology, Writing - review & editing. **Iris E.C. Sommer:** Conceptualization, Methodology, Writing - review & editing, Funding acquisition, Supervision.

#### Declaration of Competing Interest

The authors declare that they have no known competing financial interests personal relationships that could have appeared to influence the work reported in this paper.

#### Acknowledgments

The authors would like to thank Katy Thakkar, Wei Lin Toh, Kirstin

Daalman, and Sandra Escher for their help with the development of the QPE. The QPE is free for use in all public health and non-profit organizations, and can be used online or downloaded from [www.qpeinter-view.com/en](http://www.qpeinter-view.com/en). This work was supported by ZONMW-00812-98-13009).

#### References

- Aarsland, D., Ballard, C., Larsen, J.P., McKeith, I., 2001. A comparative study of psychiatric symptoms in dementia with Lewy bodies and Parkinson's disease with and without dementia. *Int. J. Geriatr. Psychiatry* 16, 528–536.
- Anketell, C., Dorahy, M.J., Shannon, M., Elder, R., Hamilton, G., Corry, M., MacSherry, A., Curran, D., O'Rawe, B., 2010. An exploratory analysis of voice hearing in chronic PTSD: potential associated mechanisms. *J. Trauma Dissoc.* 11, 93–107. <https://doi.org/10.1080/15299730903143600>.
- Askenazy, F.L., Lestideau, K., Meynadier, A., Dor, E., Myquel, M., Lecrubier, Y., 2007. Auditory hallucinations in pre-pubertal children: a one-year follow-up, preliminary findings. *Eur. Child Adolesc. Psychiatry* 16, 411–415. <https://doi.org/10.1007/s00787-006-0577-9>.
- Barnes, J., David, A.S., 2001. Visual hallucinations in Parkinson's disease: a review and phenomenological survey. *J. Neurol. Neurosurg. Psychiatry* 70, 727–733. <https://doi.org/10.1136/jnnp.70.6.727>.
- Bassiony, M.M., Lyketsos, C.G., 2003. Delusions and hallucinations in Alzheimer's disease: review of the brain decade. *Psychosomatics* 44, 388–401. <https://doi.org/10.1176/appi.psy.44.5.388>.
- Bassiony, M.M., Steinberg, M.S., Warren, A., Rosenblatt, A., Baker, A.S., Lyketsos, C.G., 2000. Delusions and hallucinations in Alzheimer's disease: prevalence and clinical correlates. *Int. J. Geriatr. Psychiatry* 15, 99–107.
- Begemann, M.J.H., Linszen, M.M.J., de Boer, J.N., Hovenga, W.D., Gangadin, S.S., Schutte, M.J.L., Sommer, I.E.C., 2019. Atopy increases risk of psychotic experiences: a large population-based study. *Front. Psychiatry* 10. <https://doi.org/10.3389/fpsy.2019.00453>.
- Black, D.W., Nasrallah, A., 1989. Hallucinations and delusions in 1,715 patients with unipolar and bipolar affective disorders. *Psychopathology* 22, 28–34. <https://doi.org/10.1159/000284576>.
- Blom, J.D., 2010. *A Dictionary of Hallucinations*. Springer Science & Business Media, New York.
- Chou, K.L., Messing, S., Oakes, D., Feldman, P.D., Breier, A., Friedman, J.H., K.L., C., S., M., D., O., P.D., F., A., B., J.H., F., Chou, K.L., Messing, S., Oakes, D., Feldman, P.D., Breier, A., Friedman, J.H., 2005. Drug-induced psychosis in Parkinson disease: phenomenology and correlations among psychosis rating instruments. *Clin. Neuropharmacol.* 28, 215–219. <https://doi.org/10.1097/01.wnf.0000180228.77802.32>.
- Cox, T.M., Ffytche, D.H., 2014. Negative outcome Charles Bonnet syndrome. *Br. J. Ophthalmol.* 98, 1236–1239. <https://doi.org/10.1136/bjophthalmol-2014-304920>.
- Cummings, J.L., Mega, M., Gray, K., Rosenberg-Thompson, S., Carusi, D.A., Gornbein, J., 1994. The Neuropsychiatric Inventory: comprehensive assessment of psychopathology in dementia. *Neurology* 44, 2308–2314. <https://doi.org/10.1212/wnl.44.12.2308>.
- Daalman, K., Boks, M.P.M.M., Dieren, K.M.J.J., de Weijer, A.D., Blom, J.D., Kahn, R.S., Sommer, I.E.C.C., 2011. The same or different? A phenomenological comparison of auditory verbal hallucinations in healthy and psychotic individuals. *J. Clin. Psychiatry* 72, 320–325. <https://doi.org/10.4088/JCP.09m05797yel>.
- Daalman, K., Dieren, K.M.J., Hoekema, L., van Lutterveld, R., Sommer, I.E.C., 2016. Five year follow-up of non-psychotic adults with frequent auditory verbal hallucinations: are they still healthy? *Psychol. Med.* 46, 1897–1907. <https://doi.org/10.1017/S0033291716000386>.
- de Boer, J.N., Linszen, M.M.J., de Vries, J., Schutte, M.J.L., Begemann, M.J.H., Heringa, S.M., Bohlken, M.M., Hugdahl, K., Aleman, A., Wijnen, F.N.K., Sommer, I.E.C., 2019. Auditory hallucinations, top-down processing and language perception: a general population study. *Psychol. Med.* 49 (16), 1–9. <https://doi.org/10.1017/S003329171800380x>.
- Ely, E.W., Margolin, R., Francis, J., May, L., Truman, B., Dittus, R., Speroff, T., Gautam, S., Bernard, G.R., Inouye, S.K., 2001. Evaluation of delirium in critically ill patients: validation of the confusion assessment method for the intensive care unit (CAM-ICU). *Crit. Care Med.* 29, 1370–1379. <https://doi.org/10.1097/00003246-200107000-00012>.
- Fénelon, G., Soulas, T., Cleret de Langavant, L., Trinkler, I., Bachoud-Lévi, A.-C., 2011. Feeling of presence in Parkinson's disease. *J. Neurol. Neurosurg. Psychiatry* 82, 1219–1224. <https://doi.org/10.1136/jnnp.2010.234799>.
- Ffytche, D.H., Creese, B., Politis, M., Chaudhuri, K.R., Weintraub, D., Ballard, C., Aarsland, D., 2017. The psychosis spectrum in Parkinson disease. *Nat. Rev. Neurol.* 13, 81–95. <https://doi.org/10.1038/nrneurol.2016.200>.
- Folstein, M.F., Folstein, S.E., McHugh, P.R., 1975. "Mini-mental state": A practical method for grading the cognitive state of patients for the clinician. *J. Psychiatr. Res.* 12, 189–198. [https://doi.org/10.1016/0022-3956\(75\)90026-6](https://doi.org/10.1016/0022-3956(75)90026-6).
- Forsaa, E.B., Larsen, J.P., Wentzel-Larsen, T., Goetz, C.G., Stebbins, G.T., Aarsland, D., Alves, G., 2010. A 12-year population-based study of psychosis in Parkinson disease. *Arch. Neurol.* 67, 996–1001. <https://doi.org/10.1001/archneurol.2010.166>.
- Goodwin, F.K., Jamison, K.R., Ghaemi, S.N., 2007. *Manic-Depressive Illness: Bipolar Disorders and Recurrent Depression*. Oxford University Press.
- Hepworth, C.R., Ashcroft, K., Kingdon, D., 2013. Auditory hallucinations: a comparison of beliefs about voices in individuals with schizophrenia and borderline personality disorder. *Clin. Psychol. Psychother.* 20, 239–245. <https://doi.org/10.1002/cpp.791>.
- Insel, T., Cuthbert, B., Garvey, M., Heinssen, R., Pine, D., Quinn, K., Sanislow, C., Wang,



- P., 2010. Research domain criteria (RDoC): toward a. *Am. J. Psychiatry Online* 748–751. <https://doi.org/10.1176/appi.ajp.2010.09091379>.
- Jurišić, D., Sesar, I., Čavar, I., Sesar, A., Živković, M., Čurković, M., 2018. Hallucinatory experiences in visually impaired individuals: Charles Bonnet syndrome - implications for research and clinical practice. *Psychiatr. Danub.* 30, 122–128. <https://doi.org/10.24869/psyd.2018.122>.
- Kay, S.R., Fiszbein, A., Opler, L.A., 1987. The positive and negative syndrome scale (PANSS) for schizophrenia. *Schizophr. Bull.* 13, 261–276. <https://doi.org/10.1093/schbul/13.2.261>.
- Kaymaz, N., van Os, J., 2010. Extended psychosis phenotype—yes: single continuum—unlikely. *Psychol. Med.* 40, 1963–1966. <https://doi.org/10.1017/S0033291710000358>.
- Kingdon, D.G., Ashcroft, K., Bhandari, B., Gleeson, S., Warikoo, N., Symons, M., Taylor, L., Lucas, E., Mahendra, R., Ghosh, S., Mason, A., Badrakalimuthu, R., Hepworth, C., Read, J., Mehta, R., 2010. Schizophrenia and borderline personality disorder: similarities and differences in the experience of auditory hallucinations, paranoia, and childhood trauma. *J. Nerv. Ment. Dis.* 198, 399–403. <https://doi.org/10.1097/NMD.0b013e3181e08c27>.
- Krabbendam, L., Myin-Germeys, I., Hanssen, M., Bijl, R.V., de Graaf, R., Vollebergh, W., Bak, M., van Os, J., 2004. Hallucinatory experiences and onset of psychotic disorder: evidence that the risk is mediated by delusion formation. *Acta Psychiatr. Scand.* 110, 264–272. <https://doi.org/10.1111/j.1600-0447.2004.00343.x>.
- Larøi, F., Sommer, I.E., Blom, J.D., Fernyhough, C., Ffytche, D.H., Hugdahl, K., Johns, L.C., McCarthy-Jones, S., Preti, A., Raballo, A., Slotema, C.W., Stephane, M., Waters, F., 2012. The characteristic features of auditory verbal hallucinations in clinical and nonclinical groups: state-of-the-art overview and future directions. *Schizophr. Bull.* 38, 724–733. <https://doi.org/10.1093/schbul/sbs061>.
- Lecrubier, Y., Perry, R., Milligan, G., Leeuwenkamp, O., Morlock, R., 2007. Physician observations and perceptions of positive and negative symptoms of schizophrenia: a multinational, cross-sectional survey. *Eur. Psychiatry* 22, 371–379. <https://doi.org/10.1016/j.eurpsy.2007.03.003>.
- Linszen, M.M.J., van Zanten, G.A., Teunisse, R.J., Brouwer, R.M., Scheltens, P., Sommer, I.E., 2019. Auditory hallucinations in adults with hearing impairment: a large prevalence study. *Psychol. Med.* 49, 132–139. <https://doi.org/10.1017/S0033291718000594>.
- Llorca, P.M., Pereira, B., Jardri, R., Chereau-Boudet, I., Brousse, G., Misdráhi, D., Fénelon, G., Tronche, A.M., Schwan, R., Lançon, C., Marques, A., Ulla, M., Derost, P., Debilly, B., Durif, F., De Chazeron, I., 2016. Hallucinations in schizophrenia and Parkinson's disease: an analysis of sensory modalities involved and the repercussion on patients. *Sci. Rep.* 6. <https://doi.org/10.1038/srep38152>.
- McCarthy-Jones, S., Thomas, N., Strauss, C., Dodgson, G., Jones, N., Woods, A., Brewin, C.R., Hayward, M., Stephane, M., Barton, J., Kingdon, D., Sommer, I.E., 2014. Better than mermaids and stray dogs? Subtyping auditory verbal hallucinations and its implications for research and practice. *Schizophr. Bull.* 40 (4), S275–S284. <https://doi.org/10.1093/schbul/sbu018>.
- McKeith, I., Mintzer, J., Aarsland, D., Burn, D., Chiu, H., Cohen-Mansfield, J., Dickson, D., Dubois, B., Duda, J.E., Feldman, H., Gauthier, S., Halliday, G., Lawlor, B., Lipka, C., Lopez, O.L., Machado, Carlos, J., O'Brien, J., Playfer, J., Reid, W., International Psychogeriatric Association Expert Meeting on DLB, 2004. Dementia with Lewy bodies. *Lancet. Neurol.* 3, 19–28.
- Nagahama, Y., Okina, T., Suzuki, N., Matsuda, M., Fukao, K., Murai, T., 2007. Classification of psychotic symptoms in dementia with Lewy bodies. *Am. J. Geriatr. Psychiatry* 15, 961–967. <https://doi.org/10.1097/JGP.0b013e3180cc1fdf>.
- Overall, J.E., Gorham, D.R., 1962. The brief psychiatric rating scale. *Psychol. Rep.* 10, 799–812. <https://doi.org/10.2466/pr0.1962.10.3.799>.
- Perälä, J., Kuoppasalmi, K., Pirkola, S., Härkänen, T., Saarni, S., Tuulio-Henriksson, A., Viertiö, S., Latvala, A., Koskinen, S., Lönnqvist, J., Suvisaari, J., 2010. Alcohol-induced psychotic disorder and delirium in the general population. *Br. J. Psychiatry* 197, 200–206. <https://doi.org/10.1192/bjp.bp.109.070797>.
- Poulton, R., Caspi, A., Moffitt, T.E., Cannon, M., Murray, R., Harrington, H., 2000. Children's self-reported psychotic symptoms and adult schizophreniform disorder: a 15-year longitudinal study. *Arch. Gen. Psychiatry* 57, 1053–1058. <https://doi.org/10.1001/archpsyc.57.11.1053>.
- Reeves, S.J., Gould, R.L., Powell, J.F., Howard, R.J., 2012. Origins of delusions in Alzheimer's disease. *Neurosci. Biobehav. Rev.* 36, 2274–2287. <https://doi.org/10.1016/j.neubiorev.2012.08.001>.
- Rossell, S.L., Schutte, M.J.L., Toh, W.L., Thomas, N., Strauss, C., Linszen, M.M.J., Van Dellen, E., Heringa, S.M., Teunisse, R., Slotema, C.W., Sommer, I.E.C., 2019. The questionnaire for psychotic experiences: an examination of the validity and reliability. *Schizophr. Bull.* 45, S78–S87. <https://doi.org/10.1093/schbul/sby148>.
- Slotema, C.W., Daalman, K., Blom, J.D., Diederen, K.M., Hoek, H.W., Sommer, I.E.C., 2012. Auditory verbal hallucinations in patients with borderline personality disorder are similar to those in schizophrenia. *Psychol. Med.* 42, 1873–1878. <https://doi.org/10.1017/S0033291712000165>.
- Sommer, I.E., Kleijer, H., Hugdahl, K., 2018. Toward personalized treatment of hallucinations. *Curr. Opin. Psychiatry*. <https://doi.org/10.1097/YCO.0000000000000416>.
- Sommer, I.E., Kooops, S., Blom, J.D., 2012. Comparison of auditory hallucinations across different disorders and syndromes. *Neuropsychiatry (London)* 2, 57–68. <https://doi.org/10.2217/npv.12.2>.
- Teunisse, R.J., Cruysberg, J.R.M., Verbeek, A., Zitman, F.G., 1995. The Charles Bonnet syndrome: a large prospective study in the Netherlands. *Br. J. Psychiatry* 166, 254–257. <https://doi.org/10.1192/bjp.166.2.254>.
- Teunisse, R.J., Rikkers, M.G.M.O., 2012. Prevalence of musical hallucinations in patients referred for audiometric testing. *Am. J. Geriatr. Psychiatry* 20, 1075–1077. <https://doi.org/10.1097/JGP.0b013e31823e31c4>.
- Toh, W.L., Thomas, N., Rossell, S.L., 2015. Auditory verbal hallucinations in bipolar disorder (BD) and major depressive disorder (MDD): a systematic review. *J. Affect. Disord.* 184, 18–28. <https://doi.org/10.1016/j.jad.2015.05.040>.
- Verhage, F., 1964. Intelligentie en leeftijd: onderzoek bij Nederlanders van twaalf tot zevenzeventig jaar [intelligence and age: study with Dutch people aged 12 to 77]. Assen Van Gorcum.
- Waters, F., Blom, J.D., Dang-Vu, T.T., Cheyne, A.J., Alderson-Day, B., Woodruff, P., Collerton, D., 2016. What is the link between hallucinations, dreams, and hypnagogic-hypnopompic experiences? *Schizophr. Bull.* 42, 1098–1109. <https://doi.org/10.1093/schbul/sbw076>.