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Predictive cues and spatial attentional bias for alcohol: Manipulations of cue-outcome mapping

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HIGHLIGHTS

- The cued Visual Probe Task (cVPT) evokes biases due to predicted stimuli.
- Such biases appear to have good split-half reliability.
- However, split-half reliability may be artificially influenced by cue features.
- Merely non-predictive cues do not produce reliable bias scores.
- The bias involves automatic processes not directly related to awareness.

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ABSTRACT

Previous studies suggest that cues predicting the outcome of attentional shifts provide a measure of anticipatory alcohol-related attentional bias that is correlated with risky drinking and has high reliability. However, this is complicated by potential contributions of visual features of cues to reliability, unrelated to their predictive value. Further, little is known of the sensitivity of the bias to variations in cue-outcome mapping manipulations, limiting our theoretical and methodological knowledge: Does the bias robustly follow varying cue-outcome mappings, or are there automatic cue-related associative processes involved? The current studies aimed to address these issues. Participants performed variations of the cued Visual Probe Task (cVPT) in which cues were non-predictive; in which there were multiple cue pairs, used simultaneously and serially; and in which the cue-outcome mapping was reversed. The major findings were, first, that previously found reliability cannot be attributed to aspects of the cues not related to outcome-prediction; second, that reliability of the bias does not survive deviations from a simple, consistent cue-outcome mapping; third, that all predictive versions of the task showed a bias towards alcohol; fourth, that the bias did not simply follow awareness of the cue-outcome mapping; and finally, that only in the case of simultaneous multiple cue pairs, an association with risky drinking was replicated. The results provide support for the reliability of the anticipatory attentional bias for alcohol, suggest that relatively persistent associative processes underlie the bias in the alcohol context, and provide a foundation for future work using the cVPT.

Spatial attention is the selection of signals associated with specific locations for further processing (Soltani & Koch, 2010). Spatial attentional biases are automatic processes that affect spatial attention due to the location of emotionally or motivationally salient stimulus categories (Cisler & Koster, 2010). Such biases can be measured by visual probe tasks (MacLeod, Mathews, & Tata, 1986; Mogg & Bradley, 1999). Alcohol-related biases have been found to be related to alcohol addiction and risky drinking (Field & Cox, 2008; Field, Mogg, Zetteler, & Bradley, 2004; Townshend & Duka, 2001, 2007), and have been theorized to play an important maintaining role in addiction via the development of abnormal incentive salience (Berridge & Robinson, 2011). However, the psychometric properties of bias scores have been questioned (Christiansen, Schoenmakers, & Field, 2015). For example, in a series of alcohol-related visual probe studies reliability was sometimes found to

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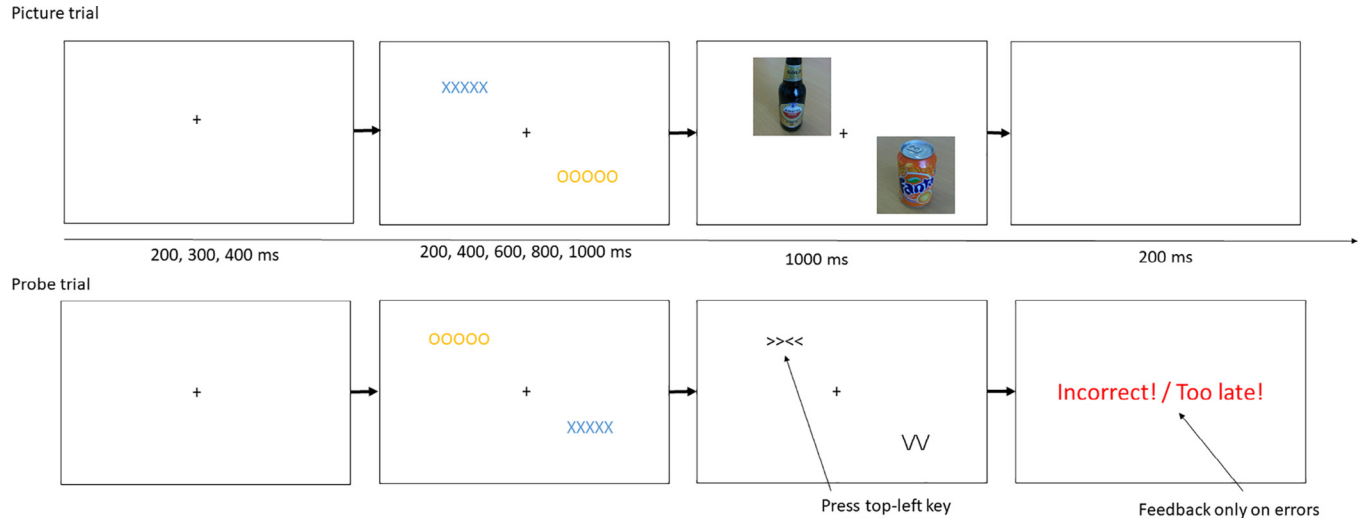

Fig. 1. Illustration of the cued Visual Probe Task (cVPT). *Note*. The Figure shows an example of a Picture (top) and Probe (bottom) trial of the cVPT task. Trials started with the predictive cues, which were replaced by exemplars from their respective categories on Picture trials. On Probe trials, a target detection probe was presented requiring a response indicating the location of the target, with high stimulus–response compatibility. Incorrect or late responses were followed by feedback.

be close to zero (Ataya et al., 2012), and reliability was only 0.19 for non-personalized alcohol stimuli in another study (Christiansen, Mansfield, Duckworth, Field, & Jones, 2015). Low reliability is a fundamental statistical limitation for analyses involving individual differences (MacLeod, Grafton, & Notebaert, 2019).

The cued Visual Probe Task, cVPT (Gladwin, 2016), may provide improved reliability. In this task (Fig. 1), blocks consist of two randomly intermixed trial types, Picture and Probe trials. On Picture trials, visually neutral cues predict the locations of subsequent salient and control stimuli. This establishes a "cue-outcome mapping", i.e., the cues acquire a predictive value related to the outcome of shifting attention to one or the other cued location: in the event a salient stimulus appears, will attention have been shifted towards or away from its location? To illustrate this, imagine being shown two identical upside-down cups and being informed a spider is under the leftmost one; attention may well become automatically drawn to that cup. Such predictive-yet-automatic processes have been posited by, e.g., the R^3 model of dual processes, discussed in more detail elsewhere (Gladwin & Figner, 2014). On Probe trials, the cues are instead followed by probe stimuli instead of the pictures. Responses are required on Probe trials. Essentially, any bias on such trials is not stimulus-driven in the sense of being evoked by actually presented salient stimuli; rather, the predictive value of the cues produces an "anticipatory" attentional bias. Support for an interpretation in terms of predictive processes, rather than merely the acquisition of salience by visual features of the cues, has thus far been provided for threat stimuli (Gladwin, Möbius, & Becker, 2019). The anticipatory attentional bias towards alcohol has been shown to be correlated with risky drinking in two previous studies (Gladwin, 2019; Gladwin & Vink, 2018). It has been found to have good split-half reliability, in the 0.7 to 0.8 range (Gladwin, 2019), possibly due to the fact that it does not depend on specific items from stimulus categories. Further, potentially complex reactions to the actual presentation of stimuli are avoided (Noël et al., 2006; Vollstädt-Klein, Loeber, von der Goltz, Mann, & Kiefer, 2009). However, there is a problem: individual differences merely involving the visual features of the predictive cues could potentially affect reliability (Gladwin, Figner, & Vink, 2019). If an individual has a systematic bias involving these features, this would increase split-half reliability regardless of outcome-related processes.

The current series of studies aim, first, to validate the previous finding of a reliable alcohol-related anticipatory attentional bias by determining whether non-predictive cues fail to result in reliable bias scores related merely to the cues' visual features. Second, to explore the robustness of the cue-outcome mapping to manipulations by using multiple cue pairs simultaneously and sequentially and by reversing the cue-outcome mapping. This will provide information on whether such manipulations should be used in future studies and may help to understand the nature of the anticipatory attentional bias for alcohol.

1. General methods

We here give the methods common to all studies. Exceptions are then provided per study.

1.1. Participants

All studies were performed online and were approved by the local ethical review board. Participants performed the study for course credit or a small financial reward. They were adults and provided informed consent. Participants were rejected for having accuracy below 80%.

1.2. Materials

The AUDIT measures risky drinking (Saunders, Aasland, Babor, de La Fuente, & Grant, 1993), containing 10 questions involving alcohol use and consequences scored on Likert scales.

The basic trial structure of the cVPT was the same in all studies, with variations described per study. All trial types and trial features, such as varying duration, were selected randomly with equal probability unless otherwise stated. Picture trials started with a fixation cross (150, 200, or 250 ms) followed by two cues (400 ms). Cues symbols were a XXXXX and OOOOO, in yellow and cyan; colour was randomly assigned per participant to symbols. The cues were presented on diagonal positions that alternated per trial, either at the top-left and bottom-right of the screen, or the top-right and bottom-left of the screen. The cues subtended around 3.5 degrees horizontally and 1 degree vertically. Each cue was replaced by a colour picture presented at the cue's location, one of an alcoholic and one of a non-alcoholic beverage (around 5 degrees visual angle horizontally and vertically). The relationship between the location of the cue and the location of stimuli from the different categories varied over the different studies. Pictures remained onscreen for 1000 ms. This was followed by a 200 ms inter-trial interval with blank screen. Probe trials started identically to Picture trials. However, no pictures were presented. Instead, cues were

replaced by probe stimuli: a target, ≫≪, and a distractor, either //\\ or \\//. The location of the target relative to the cues was random. Participants had to indicate the position of the target, as top-right (R key), bottom-right (F key), bottom-left (J key) and top-left (I key), within 1000 ms. The R and F keys were to be pressed using the left hand and the J and I keys with the right hand. This provided a simple stimulus–response mapping between the target location and the position of response keys. After an incorrect response, the text "Incorrect" appeared in red for the 200 ms intertrial interval. If no response was given in the response window, the text "Too late!" appeared.

1.3. Procedure

Studies began with instructions and informed consent, followed by demographic information and the AUDIT questionnaire. Participants then performed study-specific cVPTs.

1.4. Preprocessing and statistical analyses

Trials that likely involved states deviating from normal task performance were removed from analysis: the first four trials per task, the first trial per block, error trials, trials following an error, and trials with an RT more than 3 SDs from the mean value for the trial type. The first four blocks were removed to make results comparable over cVPT tasks, in most of which these blocks were used for training the cue-outcome mapping; these were followed by 8 blocks used for assessment.

The bias per participant was defined as the median RT for probes on the predicted alcohol minus non-alcohol location. Split-half reliability of the bias was calculated using Spearman's correlation between even versus odd blocks with Spearman-Brown correction; if the split-half correlation was negative, the correction was not applied. Spearman's correlations were used to test the association between bias and AUDIT scores.

1.4.1. Study 1. Can reliability of bias scores be explained by individual differences related to the cues?

In Study 1, a cVPT was used in which the cues had no predictive value for outcomes. It was hypothesized that this would not lead to reliable cue-dependent "bias" scores. Such reliability would be caused by individual differences merely involving visual features of the cues and would hence undermine previous results.

2. Methods

2.1. Participants

The sample size was 47 (16 female, age 42.04, SD = 11.20); 5 additional participants were rejected.

2.2. Materials

Cronbach's alpha for the AUDIT was 0.89.

A non-predictive version was used of the cVPT described in the General Methods. Essentially for this non-predictive cVPT, which stimulus category appeared at which cue's location was randomized per trial.

2.3. Procedure

Participants only performed a single run of the non-predictive cVPT, of 12 blocks of 24 trials each.

2.4. Results

The average AUDIT score was 5.043 (SD = 5.26).

Crucially, the even–odd split-half correlation of the "bias" calculated using the non-predictive cues was very close to zero, $rho = -0.077$, $p = 0.61$. There was no significant difference between RTs on XXXXX versus OOOOO cues, 586 ms (SD = 155.28) versus 611 ms (SD = 154.92), $t(46) = -0.97$, $p = 0.34$, $d = -0.14$. The bias was not correlated with AUDIT scores, $rho = -0.15$, $p = 0.33$.

2.5. Discussion

Split-half reliability is extremely low with cues not having a predictive value. Essentially, this implies that individual differences involving visual features of the cues cannot plausibly have contributed to the reliability of the bias for alcohol found in previous work (Gladwin, 2019).

2.5.1. Study 2. Relationship between the bias evoked by multiple cue pairs

Study 2 aimed to determine the robustness of bias scores to using two pairs of cues. A bias score was calculated for each cue pair. As both cue pairs provided the same predictive value of outcomes, the bias scores were hypothesized to be correlated. The overall bias score was expected to be correlated with risky drinking.

3. Methods

3.1. Participants

The sample size was 70 (33 female, age 36.89, SD = 10.50); 11 additional participants were rejected.

3.2. Materials

Cronbach's alpha for the AUDIT was 0.89.

A cVPT was used with the basic structure as described in the General Methods. However, there were now two cue pairs, one of the two pairs being selected randomly per trial. One cue pair consisted of the symbols XXXXX and OOOOO, in the colours yellow and cyan. The other cue pair consisted of the symbols ——— and ||||| in the colours pink and light gray. Cues were now 100% predictive: one cue of each pair was always replaced by an alcoholic drink on Picture trials, and the other cue of the pair was replaced by a non-alcoholic drink.

3.3. Procedure

Participants performed a practice run of the cVPT (2 blocks of 24 trials each) followed by an awareness check asking which of the cues per pair was followed by an alcohol picture. This practice run and awareness check was repeated. Then the assessment cVPT of 8 blocks of 24 trials each was performed, followed by a third awareness check.

3.4. Results

The average AUDIT score in the current sample was 7.14 (SD = 7.51). The accuracy on the awareness checks, averaged over both cue pairs, was 0.59 (0.56 and 0.63 for the XXXXX/OOOOO and ———/||||| cue pairs, respectively), 0.83 (0.84 and 0.81, respectively) and 0.89 (0.89 and 0.90, respectively).

The even–odd blocks split-half correlation was 0.093, Spearman-Brown correction 0.17. Per cue pair separately the Spearman-Brown-corrected reliability was higher, 0.46 for XXXXX/OOOOO ($rho = 0.30$) and 0.42 for ———/||||| ($rho = 0.27$). The bias scores for the two cue pairs were uncorrelated, $rho = -0.19$, $p = 0.12$.

There was a within-subject effect of probe location indicating faster responses to probes on the predicted alcohol versus non-alcohol location, 585 ms versus 601 ms, $t(69) = -2.32$, $p = 0.023$, $d = -0.28$. There was a correlation in the expected direction between bias scores and AUDIT scores, $rho = -0.23$, $p = 0.051$, significant with a one-sided test. In exploratory analyses, differences between the bias on the

cue pairs were compared, showing an unexpected difference, $t(69) = -2.06$, $p = 0.043$, $d = -0.25$. The XXXXX/OOOOO cue pair showed a bias, $t(69) = -2.99$, $p = 0.0039$, $d = -0.36$, but the ———/||||| did not, $t(69) = 0.29$, $p = 0.77$, $d = 0.035$. Neither cue pair in isolation resulted in a significant correlation with AUDIT scores, both $p > 0.38$.

3.5. Discussion

The overall bias was not reliable. Interestingly, although participants showed high levels of awareness of both cue-outcome mappings, the associated bias scores were not correlated. Despite this, the correlation between risky drinking and bias scores, found twice previously using a single cue-pair (Gladwin, 2019; Gladwin & Vink, 2018), was replicated. It is difficult to explain the unexpected difference between the cue pairs. A speculative explanation of the overall pattern of results is that only one of the cue-pairs acquired an automatic alcohol-related predictive value related to the participants' individual differences in risky drinking; i.e., there was a one-to-one mapping from cue to alcohol rather than a many-to-one mapping, and which of the two cue pairs acquired this one-to-one mapping varied from participant to participant.

3.5.1. Study 3. Relationship between the bias evoked by sequential multiple cue pairs

Study 3 was aimed at determining the sensitivity of individual differences in bias scores to using multiple cue pairs, as in the previous study, but now the pairs were introduced one after the other rather than simultaneously. This again led to two bias scores, one for each cue pair. It was hypothesized that these two bias scores would be correlated, and that a correlation with AUDIT scores would be found.

4. Methods

4.1. Participants

The sample size was 94 (34 female and 60 male, age = 35.87, $SD = 9.14$). 5 participants were rejected.

4.2. Materials

Cronbach's alpha for the AUDIT was 0.87.

A cVPT was used with the same trials as in the General Methods. However, there were now two cue pairs, one of which was used in the first half of the experiment and the other in the second half. One cue pair consisted of the symbols XXXXX and OOOOO, in the colours yellow and cyan. The other cue pair consisted of the symbols ——— and ||||| in the colours pink and light gray. Cues were 100% predictive: one cue of each pair was always replaced by an alcoholic drink on Picture trials, and the other cue of the pair was replaced by a non-alcoholic drink.

4.3. Procedure

Participants performed a practice run of the cVPT (2 blocks of 24 trials each) followed by an awareness check asking which of the cues per pair was followed by an alcohol picture. This practice run and awareness check was repeated. Then the assessment cVPT of 8 blocks was performed, followed by an awareness check. The practice runs, assessment and awareness checks were then repeated using the second cue pair. The order of cue pairs was randomized per participant.

4.4. Preprocessing and statistical analyses

Split-half reliability of the bias was calculated for even and odd blocks, as well as for the two cue pairs.

4.5. Results

The average AUDIT score in the current sample was 5.63 ($SD = 5.22$). The accuracy on the awareness checks at the six check points was 0.55, 0.88, 0.89, 0.87, 0.84 and 0.87.

The even–odd split-half correlation was 0.32, Spearman-Brown correction 0.48. Per cue-pair, Spearman-Brown-corrected reliability was 0.57 for XXXXX/OOOOO ($rho = 0.40$) and 0.62 for ———/||||| ($rho = 0.45$). The correlation between the bias scores for the first and second cue pairs was 0.048, $p = 0.65$.

There was a significant overall within-subject effect of probe location indicating faster responses to probes on the predicted alcohol versus non-alcohol location, 565 ms versus 580 ms, $t(93) = -2.52$, $p = 0.013$, $d = -0.26$. There was no difference in bias between the first and second halves of the procedure, $t(93) = -0.85$, $p = 0.40$, $d = -0.088$. There was no correlation between bias scores and AUDIT scores, $rho = 0.017$, $p = 0.87$; there was also no correlation for either the first or second half separately, $p > 0.60$.

4.6. Discussion

A modest split-half reliability was found, but the correlation between the two bias scores was very low, as was the case with two different cue pairs used simultaneously. As in Study 2, there was a significant overall alcohol-related bias, but no correlation with risky drinking. This could be due to the complexity in the design, involving different cues and a cue switch halfway through, all of which could induce noise and multiple influences affecting individual differences.

4.6.1. Study 4. Effects of reversing the cue-outcome mapping

Study 4 was aimed at determining the effect of reversing the cue – outcome mapping: the cue previously predicting alcohol was changed to predict non-alcohol, and vice versa. It was hypothesized that the bias before and after reversal would be positively correlated, i.e., that the bias would follow the predicted outcome after a reversal, rather than the original cue. Further, a correlation of the overall bias with AUDIT scores was expected.

5. Methods

5.1. Participants

The sample size was 76 (40 female, age = 39.66, $SD = 9.83$). 5 participants were rejected.

5.2. Materials

Cronbach's alpha of the AUDIT was 0.89.

A cVPT was used with the basic structure as described in the General Methods. Given a cue-outcome mapping, cues were 100% predictive: one cue was always replaced by an alcoholic drink on Picture trials, and the other cue of the pair was always replaced by a non-alcoholic drink.

5.3. Procedure

Participants performed a practice task of the cVPT (2 blocks of 24 trials each) followed by an awareness check asking which of the cues per pair was followed by an alcohol picture. This practice task and awareness check was repeated. Then the assessment task of 8 blocks was performed, followed by a third awareness check. The tasks and awareness checks were then repeated with the reversed cue-outcome mapping. The order of mappings was random.

5.4. Preprocessing and statistical analyses

The same preprocessing steps as described in the General Methods

were used.

The bias was defined as the median RT for the alcohol versus non-alcohol cue location. Split-half reliability of the bias was calculated for even and odd blocks, as well as for the two halves of the experiment (i.e., initial versus reversed cue mapping). The overall bias was tested using a within-subject *t*-test. Spearman's correlations were sued to test the association between bias and AUDIT scores.

5.5. Results

The average AUDIT score in the current sample was 5.32 ($SD = 4.87$). The accuracy on the awareness checks at the six check points was 0.54, 0.87, 0.93, 0.88, 0.88 and 0.96.

The even–odd block split-half correlation was 0.0029, with an associated Spearman-Brown reliability of 0.0058. The correlation between the bias scores for the two mappings (i.e., the first and second half of the procedure) was significantly negative, $rho = -0.29$, $p = 0.0071$.

There was a significant overall bias towards probes on the predicted alcohol versus non-alcohol location, 579 ms versus 583 ms, $t(75) = -2.26$, $p = 0.026$, $d = -0.26$. Exploratory analyses showed that this bias was only found before the reversal, 599 ms versus 616 ms, $t(75) = -4.14$, $p < 0.001$, $d = -0.48$, and not after it, 585 ms versus 582 ms, $t(75) = 0.89$, $p = 0.37$, $d = 0.10$; this difference in bias before and after the reversal was significant, $t(75) = -3.24$, $p = 0.0018$, $d = -0.37$. There was no correlation between bias scores and AUDIT scores, $rho = 0.15$, $p = 0.18$. There was also no correlation either before the reversal, $rho = 0.13$, $p = 0.27$, or after it, $rho = 0.056$, $p = 0.63$.

5.6. Discussion

An overall bias was found, although this was due to the pre-reversal bias. Reliability of individual differences was close to zero, and an unexpected negative correlation was found between pre- and post-reversal bias scores. This complements the previous findings suggesting a one-to-one association between predicted alcohol stimuli and a predictive cue: This association further appears to be resistant to change, despite similarly high levels of awareness of cue-outcome mapping after as before the reversal. The results thus imply that the bias is not merely a consequence of conscious awareness or preference. Results clearly diverge from results for threat stimuli, when reliability survived reversal (Gladwin, Figner, et al., 2019).

6. General discussion

The current studies aimed to validate the reliability of the anticipatory attentional bias derived from the cVPT for alcohol and to explore manipulations of cue-outcome mapping. Supporting the validity of previously found reliability (Gladwin, 2019), reliability was lost when cues were made non-predictive. Reliability of the anticipatory attentional bias was lower in the current studies, in which cue-outcome mapping was not a simple one-to-one mapping as was the case in previous work. Further, the current task versions did not show previously found correlations with risky drinking, but rather an overall bias towards alcohol. This suggests that processes related to risky drinking are reflected in one particular cue acquiring salience due to its prediction of alcohol-related stimuli. Alcohol-related anticipatory attentional bias thus appears to involve different processes than threat-related anticipatory attentional bias, which does appear to reflect processing related to the predicted outcomes rather than the acquisition of salience by a particular cue (Gladwin, Figner, et al., 2019; Gladwin, Möbius, et al., 2019).

Limitations were the convenience sample and online data collection. It would appear that the cVPT now could be applied to clinical or high-risk groups. While online studies have pragmatic benefits and can provide valid data (Chetverikov & Upravitelev, 2016), clearly it would be of interest to replicate online results using laboratory measurements.

In conclusion, high previously found reliability of anticipatory, or predictive cue-evoked, attentional bias scores for alcohol can be attributed to the predictive value of the cues. The bias for alcohol appears to involve the automatic, relatively rigid acquisition of salience by cues. Future studies should use simple cue-outcome mappings to optimize reliability.

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There was no funding for this study.

8. Contributors

TEG and BF conceptualized the study. TG, MV and BF contributed to data collection. TG implemented the study and analysed the data. TG and MB wrote the first draft of the manuscript. All authors contributed to and have approved the final manuscript

CRediT authorship contribution statement

Thomas E. Gladwin: Conceptualization, Data curation, Methodology, Resources, Software, Writing - original draft, Writing - review & editing. **Milena Banic:** Conceptualization, Writing - review & editing. **Bernd Figner:** Conceptualization, Resources, Writing - review & editing. **Matthijs Vink:** Conceptualization, Resources, Writing - review & editing.

Declaration of Competing Interest

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

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.addbeh.2019.106247.

References

Ataya, A. F., Adams, S., Mullings, E., Cooper, R. M., Attwood, A. S., & Munafò, M. R. (2012). Internal reliability of measures of substance-related cognitive bias. *Drug and Alcohol Dependence, 121*(1–2), 148–151. https://doi.org/10.1016/j.drugalcdep.2011.08.023.

Berridge, K. C., & Robinson, T. E. (2011). Drug addiction as incentive sensitization. *Addiction and Responsibility, 21–54*. https://doi.org/10.1080/09515089.2013.785069.

Chetverikov, A., & Upravitelev, P. (2016). Online versus offline: The Web as a medium for response time data collection. *Behavior Research Methods, 48*(3), 1086–1099. https://doi.org/10.3758/s13428-015-0632-x.

Christiansen, P., Mansfield, R., Duckworth, J., Field, M., & Jones, A. (2015). Internal reliability of the alcohol-related visual probe task is increased by utilising personalised stimuli and eye-tracking. *Drug and Alcohol Dependence, 155*, 170–174. https://doi.org/10.1016/j.drugalcdep.2015.07.672.

Christiansen, P., Schoenmakers, T. M., & Field, M. (2015). Less than meets the eye: Reappraising the clinical relevance of attentional bias in addiction. *Addictive Behaviors, 44*, 43–50. https://doi.org/10.1016/j.addbeh.2014.10.005.

Cisler, J. M., & Koster, E. H. W. (2010). Mechanisms of attentional biases towards threat in anxiety disorders: An integrative review. *Clinical Psychology Review, 30*(2), 203–216. https://doi.org/10.1016/j.cpr.2009.11.003.

Field, M., & Cox, W. M. (2008). Attentional bias in addictive behaviors: A review of its development, causes, and consequences. *Drug and Alcohol Dependence, 97*(1–2), 1–20. https://doi.org/10.1016/j.drugalcdep.2008.03.030.

Field, M., Mogg, K., Zetteler, J., & Bradley, B. P. (2004). Attentional biases for alcohol cues in heavy and light social drinkers: The roles of initial orienting and maintained attention. *Psychopharmacology, 176*(1), 88–93. https://doi.org/10.1007/s00213-004-1855-1.

Gladwin, T. E. (2016). Attentional bias variability and cued attentional bias for alcohol stimuli. *Addiction Research and Theory, 25*(1), 32–38. https://doi.org/10.1080/16066359.2016.1196674.

Gladwin, T. E. (2019). Spatial anticipatory attentional bias for alcohol: A preliminary

report on Reli and associations with risky drinking. Alcoholism and Drug Addiction. doi:10.31234/OSF.IO/WP6S5.

Gladwin, T. E., & Figner, B. (2014). "Hot" cognition and dual systems: Introduction, criticisms, and ways forward. In E. Wilhelms, & V. F. Reyna (Eds.). *Frontiers of cognitive psychology series: Neuroeconomics, judgment and decision making* (pp. 157–180). New York: Psychology Press.

Gladwin, T. E., Figner, B., & Vink, M. (2019). Anticipation-specific reliability and trial-to-trial carryover of anticipatory attentional bias for threat. Journal of Cognitive Psychology. doi:10.1080/20445911.2019.1659801.

Gladwin, T. E., Möbius, M., & Becker, E. S. (2019). Predictive attentional bias modification induces stimulus-evoked attentional bias for threat. Europe's Journal of Psychology, In press.

Gladwin, T. E., & Vink, M. (2018). Alcohol-related attentional bias variability and conflicting automatic associations. *Journal of Experimental Psychopathology, 9*(2), https://doi.org/10.5127/jep.062317.

MacLeod, C. M., Grafton, B., & Notebaert, L. (2019). Anxiety-linked attentional bias: Is it reliable? Annual Review of Clinical Psychology, 15(1), doi10.1146/annurev-clinpsy-050718-095505.

MacLeod, C. M., Mathews, A., & Tata, P. (1986). Attentional bias in emotional disorders. *Journal of Abnormal Psychology, 95*(1), 15–20.

Mogg, K., & Bradley, B. P. (1999). Orienting of Attention to Threatening Facial Expressions Presented under Conditions of Restricted Awareness. *Cognition & Emotion, 13*(6), 713–740. https://doi.org/10.1080/026999399379050.

Noël, X., Colmant, M., Van Der Linden, M., Bechara, A., Bullens, Q., Hanak, C., & Verbanck, P. (2006). Time course of attention for alcohol cues in abstinent alcoholic patients: The role of initial orienting. *Alcoholism, Clinical and Experimental Research, 30*(11), 1871–1877. https://doi.org/10.1111/j.1530-0277.2006.00224.x.

Saunders, J. B., Aasland, O. G., Babor, T. F., de La Fuente, J. R., & Grant, M. (1993). Development of the alcohol use disorders identification test (AUDIT): WHO collaborative project on early detection of persons with harmful alcohol consumption–II. *Addiction (Abingdon, England), 88*(6), 791–804.

Soltani, A., & Koch, C. (2010). Visual saliency computations: Mechanisms, constraints, and the effect of feedback. *Journal of Neuroscience.* https://doi.org/10.1523/JNEUROSCI.1517-10.2010.

Townshend, J. M., & Duka, T. (2001). Attentional bias associated with alcohol cues: Differences between heavy and occasional social drinkers. *Psychopharmacology, 157*(1), 67–74. https://doi.org/10.1007/s002130100764.

Townshend, J. M., & Duka, T. (2007). Avoidance of alcohol-related stimuli in alcohol-dependent inpatients. *Alcoholism, Clinical and Experimental Research, 31*(8), 1349–1357. https://doi.org/10.1111/j.1530-0277.2007.00429.x.

Vollstädt-Klein, S., Loeber, S., von der Goltz, C., Mann, K., & Kiefer, F. (2009). Avoidance of alcohol-related stimuli increases during the early stage of abstinence in alcohol-dependent patients. *Alcohol and Alcoholism (Oxford, Oxfordshire), 44*(5), 458–463. https://doi.org/10.1093/alcalc/agp056.