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The potential role of temporal dynamics in approach biases: delay-dependence of a general approach bias in an alcohol approach-avoidance task

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INTRODUCTION

Attractive cues have been shown to evoke automatic approach biases in tasks such as the Automatic Approach Task or Stimulus Response Compatibility task. An important but as yet not studied question is the role of temporal dynamics in such tasks: the impact of automatic processes may depend on the interval between cue and response. The current proof of principle study tested this hypothesized time-dependence of the approach bias. Secondary goals included the exploration of effects of alcohol cues and virtual hand stimuli. 22 participants performed an SRC task in which the delay between the presentation of the cue and the possibility to select the response was manipulated. Results revealed an approach bias that decayed over longer delays. Thus, the approach bias was indeed dependent on processes that are transiently evoked by cues. The results did not show significant effects of alcohol cues or a virtual hand. Temporal dynamics may be an essential feature of approach biases.

Keywords: automatic, approach bias, src, delay
the interval between distractors and task stimuli (Gladwin and Wiers, 2011): alcohol stimuli in a secondary task cause a relatively prolonged distracting effect on performance. However, to our knowledge temporal effects have not been studied in the context of the alcohol approach bias in motor responses. When an alcohol cue is perceived, an approach response bias is expected (see e.g., Wiers et al., 2009; Field et al., 2011), but does this bias persist indefinitely, dissipate, or reverse as found for attentional biases?

The primary goal of the current study was therefore to provide a first step in determining the time-dependence of approach biases in an SRC. To this aim, we developed an Alcohol-Approach Task in which responses could not be selected or executed until a given delay following the cue. A second, more exploratory goal was to compare effects when using of a “virtual hand” as the movable response-stimulus, instead of the usual abstract manikin. From the perspective of embodied cognition (Garbarini and Adenzato, 2004), approach biases for appetitive stimuli may be intimately related to physical, bodily actions, such as grasping or moving the hand away from stimuli. Further, previous research has shown that subjects can experience a sense of vicarious agency of others’ hands when their movements were associated with congruent instructions (Wegner et al., 2004). We therefore hypothesized that subjects would exhibit stronger biases when moving a representation of a hand rather than a more abstract stimulus. This would more closely represent the actual act of grasping an alcoholic beverage and thereby potentially lead to enhanced effects, if in fact such effects depend on this closeness of representation.

MATERIALS AND METHODS
PARTICIPANTS AND PROCEDURE
Participants were 24 college students (four male, mean age 22, SD = 3) who participated for money (7 €) or course credit. One subject was lost due to technical problems, and one subject did not correctly perform the task, leaving 22 subjects for analysis. One subject did not complete the full session; removing or including this subject did not substantially affect results. Participants signed an informed consent form and the study had the necessary IRB approval from the University of Amsterdam Ethical Committee. Subjects received verbal and written instructions and were seated in front of a computer to perform tasks: a Preference task, the SRC task, and the Hand task. Whether the hand appeared to the left or to the right of the beverage stimulus, the angle at which the subject’s own hand would be viewed if it were presented.

Hand task
The Hand task was identical to the Manikin task, except that a photographed image of a hand, in an open grasping position, replaced the manikin figure. The hand was shown roughly at the angle at which the subject’s own hand would be viewed if it were placed on a table. A left or right hand was presented depending whether the hand appeared to the left or to the right of the beverage stimulus.

STATISTICAL ANALYSIS
The first four trials of the tasks, the first trial per block, and trials with reaction times below 150 ms or above 1500 ms were excluded from analysis. Reaction time (RT) and accuracy of responses to the appearance of the manikin or hand were analyzed using repeated measures MANOVA. One MANOVA tested the differences between RT scores over different conditions for the different within-subject conditions; another MANOVA tested the accuracy scores. The within-subject factors for each MANOVA were Response-Stimulus (Hand versus Manikin), Alcohol (alcoholic versus soft drink cue), Approach (required approach versus avoid response) and...
**RESULTS**

Reaction times and accuracies are presented in Table 1. The following effects on RT were found. Approach responses were significantly faster than avoid responses $[F(1,21) = 13.14, p = 0.002, \eta_p^2 = 0.39]$. Increasing delays were associated with faster responses $[F(3,19) = 282.91, p < 0.0005, \eta_p^2 = 0.98]$. Post hoc analyses comparing all six pairs of CSIs were performed using two-sided t tests. The following pairs had significant difference at a criterion of 0.05/6, i.e., using Bonferroni correction for the number of pairs to be tested (choosing 2 CSIs from the set of 4 CSIs; the same pairs were significant at a 0.05 criterion): all other CSIs versus 0 ms and both 900 ms and 600 ms versus 300 ms.

Essentially, the effects of Approach and Delay interacted $[F(3,19) = 9.90, p < 0.0005, \eta_p^2 = 0.61]$, due to decreasing approach biases for higher delays (Figure 1). Post hoc analyses of the Approach by Delay interaction were performed by testing differences in approach bias (i.e., the approach minus avoid difference score) between pairs of delays. Significant decreases over increased delay were found between 600 ms versus 300 ms, 900 versus 0 ms, and 900 versus 300 ms (all $p < 0.05/6$; additionally, ...

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**Table 1 | Behavioral results.**

<table>
<thead>
<tr>
<th></th>
<th>Manikin Soft</th>
<th>Manikin Alcohol</th>
<th>Hand Soft</th>
<th>Hand Alcohol</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Avoid</td>
<td>Approach</td>
<td>Avoid</td>
<td>Approach</td>
</tr>
<tr>
<td>Reaction time (RT)</td>
<td>535.16 (74)</td>
<td>511.41 (80)</td>
<td>514.3 (70)</td>
<td>511.7 (74)</td>
</tr>
<tr>
<td>Accuracy</td>
<td>0.93 (0.046)</td>
<td>0.94 (0.044)</td>
<td>0.94 (0.043)</td>
<td>0.93 (0.042)</td>
</tr>
</tbody>
</table>

Reaction time and accuracy data. RT, mean (SD) reaction times in ms. Accuracy, proportion of accurate responses. Manikin and Hand refer to the task versions, in which subjects moved a manikin or a virtual hand, respectively. Soft and Alcohol refer to the beverage type to approached or avoided.
for 300 ms versus 0 ms, \( p = 0.014 \). Thus, the set of the two shorter delays differed from the set of the two longer delays, but no significant difference was found between 0 and 300 ms delay, or between 600 and 900 ms delay.

On accuracy, only an effect of Delay was found \( [F(3,19) = 4.71, \ p = 0.013, \eta^2_p = 0.43] \). Post hoc two-sided t tests were performed, correcting for the six pairwise comparisons as for RT. Accuracy was higher for 600 ms and 900 ms versus 0 ms CSI; additionally, for 300 versus 0 ms, \( p = 0.03 \).

**DISCUSSION**

As hypothesized, approach biases decreased with delays, in line with the idea that the balance between reflective, task-related processing and automatic biases may involve time-dependent processes. Note that, essentially, if it were the case that the approach bias involves only a process involving execution of the movement itself, it should not depend on the time since cue presentation. In contrast, it appears that cues transiently evoke approach tendencies, independent of response execution. Evidence for a role of similar temporal dynamics in attentional tasks have been found previously (Noël et al., 2006; Townsend and Duka, 2007; Vollstädt-Klein et al., 2009; Gladwin and Wiers, 2011) and they may play a fundamental role in automatic processes related to, e.g., drug-related approach biases (Gladwin et al., 2011). If so, understanding these time-dependent effects may have clinical implications: if approach tendencies decay relatively quickly, training subjects to even slightly delay responses to drug stimuli may be effective in reducing approach behavior, possibly playing a role in the efficacy of interventions such as cognitive bias modifications using approach – avoidance retraining (Wiers et al., 2011).

We note a number of limitations of the current study. The time-dependent effects in the current study were not specific to alcohol stimuli or risky drinking. The approach bias was found for both beverage types, which may reflect general appetitive attributes of both soft drinks and alcoholic drinks for this population. Indeed, in previous research a gene-dependent approach bias was also found for both alcoholic and non-alcoholic appetitive stimuli (Wiers et al., 2009). Therefore we cannot attribute the current time-dependent approach bias to alcohol-specific processes. More delay intervals, allowing more fine-grained analyses, and the inclusion of heavier drinkers may yet reveal speed-of-decay effects that are related to alcohol. Rating scales could be added to the stimulus selections procedure in order to capture more information about the relative subjective values of the stimulus categories. Although beyond the scope of the current study, it would also be interesting to include cues evoking avoidance biases in future research, such as phobia-related or unpleasant stimuli. With such stimuli, an initial avoidance bias would be expected that decays with time, or possibly reverses to approach as control is exerted.

In the current study, delays were selected randomly per trial. Although this does not seem likely to have influenced the findings, future research should more precisely control for the number of trials per delay period.

No effects of the response-stimulus, a manikin or a hand, were found. Possibly, both stimuli led to a similar coding of responses as approach versus avoidance. Future research could yet explore this further by using actual grasping motions rather than key presses, but the current results do not seem to provide evidence for likely strong differences. If this null result proves robust, it would suggest that the neural representations of approach/avoidance that lead to biases are not closely tied to specific motor representations.

In conclusion, approach biases appear to reflect time-dependent processes that decay after cue presentation. Thus, the manipulation of the timing of responses relative to cue presentation may be of potential importance for the study of approach-avoidance biases. We did not find evidence that using stimuli that closely reflect actual body movements may be better able to evoke motivational behaviors than more abstract stimuli, although it is as yet uncertain whether different circumstances such stimuli could yet lead to significantly different effects. Studies focused on more fine-grained analyses of effects of delay would appear to be a potentially fruitful line of research, and could open novel methods such as the analysis of the speed of decay of biases.

**AUTHOR CONTRIBUTIONS**

Thomas E. Gladwin developed the aims of the experiment, designed and programmed the task and performed the statistical analyses. Thomas E. Gladwin, Sören E. Mohr and Reinout W. Wiers conducted literature searches and contributed to writing the manuscript. Sören E. Mohr recruited and measured subjects.

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**REFERENCES**


Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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