Goal-driven attentional capture by appetitive and aversive smoking-related cues in nicotine dependent smokers

Article (Supplemental Material)

Supplementary materials for article:

Goal-driven attentional capture by appetitive and aversive smoking-related cues in nicotine dependent smokers

Chris R. H. Brown [a], Sophie Forster [a], and Theodora Duka [a,b#]

[a] = University of Sussex, School of Psychology

[b] = Sussex Addiction Research and Intervention Centre (SARIC)

Corresponding author

School of Psychology, University of Sussex, Falmer, BN19QH

Email: t.duka@sussex.ac.uk

Bayesian analyses

Smoking versus non-smoking distractor differences

Within our investigation we found multiple null effects, therefore, we conducted Bayesian pairwise comparisons along with our conventional statistical analyses. One benefit of Bayesian analyses is that it provides a Bayes factor which can reveal whether a null effect reflects a lack of sensitivity (e.g. due to variability), or whether a null effect reflects a consistent lack of a difference and can be considered a 'sensitive null' (2008; 2011; 2014; 2016).

Bayes factors compare evidence for the *experimental hypothesis* (i.e. smoking stimuli will result in reduced target detection) and the *null hypothesis* (i.e. smoking stimuli will not reduce target detection). Bayes factors range from zero to infinity, with a factor of less than 1 showing evidence favouring the null, whilst a factor above 1 shows evidence favouring the experimental hypothesis. Although Bayes factors are interpreted more as a continuous scale of evidence, rather than as an absolute cut-off as with p-values (i.e. $p < .05$), if a Bayes factor is below .33 then evidence can be considered substantially favouring the null. Conversely, if a Bayes factor is above 3 then evidence can be considered substantially favouring the experimental hypothesis. If a Bayes factor is within these limits then evidence can be considered weak, or anecdotal, and further evidence should be collected in order to have a confident conclusion (Jeffreys, 1961). The closer the Bayes factor is to 1 the more inconclusive the evidence.

Pairwise Bayesian comparisons are computed using the raw mean difference of a comparison between two conditions or groups, and the standard error of this difference. This is then modelled as a normal distribution against a prior expected effect using the same scale, which ideally would be derived from a very similar previous experiment, pilot data, or meta-analysis (Dienes, 2008). The prior expected effect for the current investigation was set as an

expected difference of *A'* = .12, which reflected the expected difference between non-smoking distractors and smoking distractors, for a particular search condition. This was based on previous research in our lab which compared distraction by task-irrelevant alcohol versus non-alcohol distractors in an RSVP with the same dependent variable (Brown et al., 2018).

This prior expected effect is modelled as a normal distribution with a mean of zero, signifying a null hypothesis of no difference. The largest expected effect is then modelled as a standard deviation from this mean. This distribution of expected effect sizes, which the recorded effect size is compared against, therefore, estimates that small effect sizes are more probable than large effect size, thus making detection of evidence of these effects more likely. Alternatively, if less is known about the expected difference, then a uniform prior is set, where small effect sizes are thought to be equally probable as large effect sizes. This has the effect reducing the likelihood that strong evidence of an effect will be found, because it reduces the sensitivity to detect small effect sizes within the bounds of the prior. As is the case in the current investigation, if the effect is expected to be directional then a half-normal distribution is modelled with a single tail reaching out from the null of zero difference, as opposed to a two-tailed normal distribution.

The initial mixed measures ANOVA showed that there was no statistical difference across smoking groups, we therefore collapsed across these groups (further exploration of group differences is outlined below). We then conducted Bayesian pairwise comparisons between both aversive and appetitive smoking distractors versus the non-smoking gardening distractors. Thus yielding six different comparisons, reported in Table 1. In order to aid interpretation, we also report p-values and 95% confidence intervals. The Bayes factors were computed using a modified version of Baguley and Kaye's (2010) R code (retrieved from Dienes, 2008; our syntax is available via the OSF: osf.io/5zhnb).

The Bayes factors revealed that the only time that evidence strongly favoured the experimental hypothesis (i.e. that smoking stimuli would be more distracting than non-smoking stimuli; Bayes factor > 3), was when the aversive or appetitive distractor was congruent with the search goal. Both the p-values and 95% confidence intervals were significant and therefore consistent with the interpretation of the Bayes factors.

Search goal	Smoking distractor vs irrelevant distractor	p-value	Bayes factor	95% CI Lower bound	95% CI Upper bound
Aversive smoking	Aversive	< .001	4837128×10^9	.10	.15
	Appetitive	.059	.61	>-.01	.02
Appetitive smoking	Aversive	.392	.15	-.01	.02
	Appetitive	< .001	4918.46	.02	.06
Reading	Aversive	.739	.05	-.02	.02
	Appetitive	.739	.06	-.02	.02

Table 1. statistical results from the pairwise comparisons between *A'* in in the irrelevant gardening distractor condition and the *A'* in the aversive or appetitive smoking distractor condition, across all search conditions. Bayes factors below .33 indicate substantial evidence favouring the null hypothesis, Bayes factors above 3 indicate substantial evidence favouring the experimental hypothesis.

When the smoking distractor was incongruent with the specific smoking related search goal, for instance, when an appetitive smoking distractor was presented during an aversive smoking search goal trial, then evidence favoured the null hypothesis. Evidence of this null effect was substantial for the aversive distractor in appetitive goal condition (Bayes factor < .33), however, evidence remained inconclusive for the appetitive distractor in the aversive search goal condition, despite favouring the null hypothesis. This was consistent with both p-values and 95% confidence intervals which showed a trend for a significant effect, but failed to reach significance. As discussed in the main paper, this statistical trend was driven mainly by the non-smokers (mean *A'* difference = .02, *SD* = .06), whilst the nicotine dependent smokers showed a near zero difference (mean *A*' difference < .01, *SD* =

.04). Image ratings by the non-smoker group revealed that they judged the appetitive distractors as more unpleasant, thus meaning that the effects were likely goal-driven.

Importantly, evidence from the comparisons for both aversive and appetitive distractors favoured the null hypothesis when participants were searching for reading images, this search condition should have been the most sensitive to stimulus-driven interference from smoking distractor due to the targets having no affective association.

Comparing attentional capture between smoking groups

The main mixed measures ANOVA revealed no significant interaction between smoking status (nicotine dependent smokers, occasional smokers, non-smokers) and RSVP task performance, all *p's* > .490. It is likely, however, that the 3×3×3 mixed measures ANOVA could have been underpowered to detect group differences, and thus the null effect was due to insensitivity rather than an actual absence of an effect.

To investigate whether there was any evidence favouring a difference between non-smokers and occasional smokers, or non-smokers and nicotine dependent smokers, we compared these groups on their smoking distractor scores for each condition. These scores were computed by subtracting the *A'* for a specific target when either an appetitive or aversive smoking distractor was presented, from *A'* when the non-smoking distractor was presented. A high smoking distractor score denotes a reduced target detection sensitivity versus the non-smoking distractor, whilst a zero score would indicate no difference between smoking and non-smoking distractors.

We based the prior expected effect on the logic that smokers could plausibly show the largest expected smoking distractor score within the current investigation (distractor score = .12), whilst non-smokers could plausibly show no smoking distractor effect (distractor score = 0). We, therefore, selected a prior expected effect of .12, which we modelled on a half-normal distribution with a mean of zero.

As can be seen in Table 2, all comparisons between occasional smokers and nicotine dependent smokers versus non-smokers were non-significant, all *p*'s > .441. Additionally, all Bayes factors favoured the null hypothesis, that is, that occasional smokers and nicotine dependent smokers would be no more distracted by smoking stimuli compared to non-smokers. All but one of these Bayes factors showed substantial evidence favouring the null, and even this Bayes factor was nearly below the threshold of substantial evidence, i.e. Bayes factor < .33. This strong and consistent evidence favouring the null suggests that our current results were not due to a lack of statistical power (Dienes, 2014). We can, therefore, conclude that nicotine dependence had no influence upon involuntary attentional capture by smoking distractors in the current task, and that this was true for both goal-driven and stimulus-driven conditions.

		NS vs OS		NS vs NDS	
Search goal	Smoking distractor effect	p-value	Bayes factor	p-value	Bayes factor
Aversive	Aversive	.682	.37	.872	.27
	Appetitive	.621	.09	.373	.07
Appetitive	Aversive	.514	.11	.622	.19
	Appetitive	.441	.08	.838	.23
Reading	Aversive	.388	.11	.918	.2
	Appetitive	.889	.17	.983	.19

Table 2. p-values and Bayes factors from the pairwise comparisons of distractor effects between OS (occasional smokers) and NS (non-smokers), and NS and NDS (nicotine dependent smokers). Distractor effects are computed by subtracting the *A'* when the distractor is a smoking related distractor from the *A*' when the distractor was a completely irrelevant gardening distractor. Bayes factors below .33 indicate substantial evidence favouring the null hypothesis, Bayes factors above 3 indicate substantial evidence favouring the experimental hypothesis (Jeffreys, 1961).

References

Baguley, T., Kaye, W.S., 2010. Review of ‘‘Understanding Psychology as a Science: An Introduction to Scientific and Statistical Inference’’. Br. J. Math. Stat. Psychol. 63, 695–698.

Brown, C.R.H., Duka, T., Forster, S. 2018. Attentional capture by alcohol related stimuli may be activated by top-down search goals. Psychopharmacology.

Dienes, Z., 2008. Understanding psychology as a science: An introduction to scientific and statistical inference. Hampshire, England: Palgrave Macmillan. Retrieved from http://www.lifesci.sussex.ac.uk/home /Zoltan_Dienes/inference/

Dienes, Z., 2011. Bayesian versus orthodox statistics: Which side are you on?. Perspect. Psychol. Sci. 6, 274-290.

Dienes, Z., 2014. Using Bayes to get the most out of non-significant results. Frontiers. Psychol. 5.

Dienes, Z., 2016. How Bayes factors change scientific practice. J. Math. Psychol. 72, 78-89.

Jeffreys H., 1961. Theory of Probability. Oxford: Clarendon Press.