

# Relationships between Attentional Bias and craving in Alcohol Use Disorder: Role of metacognitions

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Running head: Metacognition, Attentional Bias and craving

## Relationships between Attentional Bias and craving in Alcohol Use Disorder: role of

## metacognitions

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## <u>Abstract</u>

Researchers have claimed that craving and Attentional Bias (AB) towards alcohol-related cues can be explained by a common incentive-salience mechanism. However, the exact relationship between AB and craving is a matter of debate. The aim of this study was to show that metacognitions moderate the effect of AB on craving. A sample of 38 alcohol abusers undergoing post-withdrawal treating in a hospital setting completed the visual Dot Probe Detection Task (DPDT), while both pre- and post-task measures of craving were recorded. Our results confirmed significant effects of both exposure to pictures of alcohol, and metacognitions, on craving; in particular, the interaction *Metacognition* \* *DPDT* was significant. Although we initially confirmed a significant main effect of AB on craving, it became non-significant when adjusted for inter-subject variance, and metacognitions. The effect of the interaction *AB* \* *Metacognition* on craving was not significant. Our findings support the hypothesis that craving and AB share variance, but the relationship appears to be spurious, and caused by confounding factors. We discuss these results with reference to the metacognitive model of addiction.

Keywords: craving, metacognition, Attentional Bias, Alcohol Use Disorder, cue

#### 1. Introduction

*Craving* is the expression of an intense desire directed toward the use of a drug. It motivates individuals to seek out and consume the target drug in order to experience its desired effects (Tiffany & Wray, 2012). The relationship between craving and Attentional Bias (AB) has been debated (van Lier, Pieterse, Schraagen, Postel, Vollenbroek-Hutten, de Haan, & Noordzij, 2018; Ghita, Teixidor, Monras, Ortega, Mondon, Gual,... & Gutiérrez-Maldonado, 2019). The Incentive-Sensitization Theory (IST) predicts that a repeated exposure to a drug causes changes in the brain circuitry making drug users more sensitive to incentive motivational effects of drug-related cues which may explain the relationship between craving and AB (Robinson & Berridge, 1993; Franken, 2003; Field & Cox, 2008; Manchery, Yarmush, Luerhring-Jones, & Erblich, 2017). This view is supported by studies showing a correlation between addiction Stroop interference and subjective craving (e.g., Mogg & Bradley, 2002). However, several other studies have also found modest or non-significant correlations between AB and craving (Ehrman, Robbins, Bromwell, Lankford, Monterosso, & O'Brien, 2002; Field, Duka, Eastwood, Child, Santarcangelo, & Gayton, 2007; Field, Munafò, & Franken, 2009).

These conflicting results may be explained by inter-individual differences in metacognitions. The association between metacognitions (beliefs about one's own cognitive-affective experiences and means of controlling them) and craving, as well as the transdiagnostic role of metacognitions in addictive behaviours, are well documented (Hoyer, Hacker, & Lindenmeyer, 2007; Nosen & Woody, 2009; Spada, Caselli, Nikčević, & Wells, 2015; Hammonière & Varescon, 2018). Metacognitions are purported to play a key role in the maladaptive management of intrusive experiences (e.g., craving) (Wells, 2008; Spada, Caselli, & Wells, 2013). In the triphasic metacognitive model of problem drinking (Spada et al., 2013; Spada et al., 2015), alcohol use triggers (e.g., intrusive thoughts, unwanted emotional states, or craving) are associated with the activation of metacognitions which in turn lead to maladaptive forms of coping (e.g., rumination, worry, and desire thinking) and the escalation of problematic drinking behaviour. This model assumes that both metacognitions and maladaptive forms of coping promote AB towards alcohol-related triggers increasing craving (Caselli, Martino, Spada, & Wells, 2018; Caselli, Gemelli, Spada, & Wells, 2016; Caselli & Spada, 2013). The key generic metacognitions found to play a role in predicting both craving and alcohol use include negative beliefs about the uncontrollability and

danger of thoughts, cognitive confidence, and beliefs about the need to control thoughts as measured by the Metacognitions Questionnaire (Cartwright-Hatton & Wells, 1997; Wells & Cartwright-Hatton, 2004).

In view of the above, we are hypothesizing that: (1) AB will be correlated with an increase in craving. This is in line with the IST (Robinson & Berridge, 1993) and research showing that AB towards drug-related cues triggers craving (Field et al., 2009); and (2) metacognitions will moderate the relationship between AB and craving. This is in line with the triphasic metacognitive model of problem drinking which predicts that the presence of metacognitions will activate maladaptive forms of coping (rumination, worry, and desire thinking) which in turn will be associated with AB and worsen the craving experience (Spada et al., 2013; 2015). We therefore expected that the interaction *metacognitions\*AB* would have a significant effect on craving.

2. Method

### 2.1 Participants

We recruited 38 (25 male) patients who met 6 or more Alcohol Use Disorder (AUD) criteria. They received the diagnosis of severe AUD, as defined in DSM-5 (American Psychiatric Association, 2013) and had no other drug abuse problems, except nicotine use (Table 1). Participants had been admitted to a hospital-based, substance use disorder rehabilitation center (Nimes University Hospital, France). Their mean age was 51.1 (SD=9.9) years.

Insert Table 1 about here

## 2.2 Measures

#### 2.2.1 The visual Dot Probe Detection Task (DPDT)

Patients were asked to look at a fixation cross (+), located at the center of the screen, for 1000 ms. The index finger of their dominant hand was placed on the *B* key of a standard AZERTY keyboard. A pair of pictures appeared on the screen for 500 ms, before being replaced by the probe. We chose this presentation duration because heavy drinkers have AB for alcohol-related stimuli presented for 500 ms (Townshend & Duka, 2001, Field, Mogg, Zetteler, & Bradley, 2004).

Participants were asked to indicate the location of the probe (i.e., either on right or left side of the screen) by using their index finger to press either the Q key (when the probe appeared on the left side of the screen) or the M key (when it appeared on the right side of the screen). The maximum response time was set at 2000 ms. The experiment began with 10 practice trials, with feedback. The word "OK" appeared on the screen if the response was correct, and the sentence "The cross was on the other side" appeared if the response was not correct. Next, they were shown 20 pairs x 2 picture positions x 2 cross positions (i.e., 80 trials) in fully randomized order with no feedback. The screen positions of alcohol pictures and the cross were counterbalanced. AB was determined by comparing response latencies to the dot-probe between congruent trials (the probe appeared where the alcohol-related picture had appeared) and incongruent trials (the probe appeared where the control picture had appeared) (Townshend & Duka, 2001). The task was created using OpenSesame software (version 3.2.6) (Mathôt, Schreij, & Theeuwes, 2012).

The stimuli consisted of 20 alcohol-related pictures from the Geneva Appetitive Alcohol Pictures database (Billieux, Khazaal, Oliveira, de Timary, Edel, Zebouni, Zullino, & Van der Linden, 2011). Each alcohol-related picture was matched with a control, non-alcoholic beverage, to create pairs of alcohol and control pictures. Ten pairs of pictures of landscapes (with no drinks) were selected for the practice phase. All pictures measured 1024 \* 768 pixels.

## 2.2.2. The Visual Analogue Scale for Craving (VASC)

Patients estimated their desire to consume alcohol using a VASC by marking a point on an ungraduated, 10 cm horizontal line (Mottola, 1993; Geisel, Behnke, Schneider, Wernecke, & Müller, 2016). The first question referred to the pre-task perceived level of craving (*This week, how strong was your impulse to consume alcohol?*), the second question referred to the post-task perceived level of craving (*Now, after having completed this task, how strong is your desire to consume alcohol?*). Pre- and post-task questions were formulated to indicate desire (Tiffany & Wray, 2012).

## 2.2.3. Obsessive Compulsive Drinking Scale (OCDS) (Anton, Moak, & Latham, 1996).

The OCDS is a three- factor instrument (global craving, and obsessive and compulsive subdimensions). Internal consistency was good (Cronbach' s  $\alpha = .89$ ), and test-retest correlations

were also satisfactory ( $\geq$ .89) (Chignon, Jacquesy, Mennad, Terki, Huttin, Martin, & Chabannes, 1998).

#### 2.2.4. UPPS impulsive behaviour scale (UPPS-P) (Whiteside & Lynam, 2001)

The UPPS-P assesses five dimensions on a 4-point Likert scale: 1) sensation seeking, 2) lack of premeditation, 3) lack of perseverance, 4) negative urgency, and 5) positive urgency (Cronbach's α values ranged from .70 to .84; test-retest correlations range from .84 to .92) (Billieux, Rochat, Ceschi, Carré, Offerlin-Meyer, Defeldre, Khazaal, Besche-Richard, & Van der Linden, 2012)

### 2.2.5. Metacognitions Questionnaire (MCQ-65) (Cartwright-Hatton & Wells, 1997)

The MCQ-65 assesses five metacognitions domains via 65 items rated on a 4-point Likert scale: positive beliefs about worry (MCQ1), negative beliefs about thoughts concerning uncontrollability and danger (MCQ2), cognitive confidence (MCQ3), beliefs about the need to control thoughts (MCQ4), and cognitive self-consciousness (MCQ5). Measures were reliable (Cronbach's α between .65 and .87) and valid (Larøi, Van der Linden, & d'Acremont, 2009).

#### 2.4 Neuropsychological assessments

#### 2.4.1. The Montreal Cognitive Assessment (MOCA)

The MOCA measures eight cognitive domains: visuospatial/ executive, naming, immediate memory, attention, language, abstraction, delayed recall, and orientation. (Nasreddine, Phillips, Bédirian, Charbonneau, Whitehead, Collin, ... Chertkow, 2005). We calculated scores without correction for educational level (Rossetti, Lacritz, Cullum, & Weiner, 2011; Ewert, Pelletier, Alarcon, Nalpas, Donnadieu-Rigole, Trouillet, & Perney, 2018).

#### 2.4.2. Trail Making Test - TMT (parts A and B)

The TMT A-B measures executive functions and shifting abilities (Reitan, 1958). In Part A, participants were asked to connect 25 circles, numbered from 1 to 25 in ascending order. In Part B, they were asked to connect circles containing numbers (1 to 13) and circles containing letters (A to L) in ascending order, by alternating numbers and letters (i.e., 1-A-2-B-3-C).

#### 2.4.3. The Stroop Test

The Stroop Test (Groupe de Réflexion sur l'Evaluation des Fonctions Exécutives, 2001) assesses executive functioning. The three, standard conditions were used: naming the color of the ink of printed dots (Part A), naming the color of the ink of neutral words (Part B), and naming the color of the ink of words of colors printed in incongruent colors (Part C). We recorded the completion time for the high interference condition (Part C).

## 2.5. Procedure

We recruited our participants in the context of a six-week, post-detoxification rehabilitation program run by the hospital. All were recruited during the second week after admission, in four waves, at six-month intervals. A psychologist administered the OCDS and carried out neuropsychological examinations a week before the experiment. Participants were welcomed by a psychologist before the completion of the experiment. After obtaining the informed consent, each participant completed alone the MCQ in a quiet waiting room and they moved with the psychologist to the room where the experiment was run. They answered the pre-task VASC, they completed the DPDT, and they finally answered the post-task VASC. Our participants were then debriefed by the psychologist.

## 2.6 Statistical analyses

We used the *lmer* function (*lme4* package, Bates, Maechler, Bolker & Walker, 2013) to test mixed-effects models (restricted maximum likelihood) with the *R* software (R core team, 2013). The VASC score is the response variable and fixed effects comprise: the intercept, MCQ-65 scores, and *Time* (modeled as a dummy). The pre-task VASC measure was taken as the reference level. We added a random effect to the intercept (as measures for each participant were interdependent). The AB score was obtained by removing latency data from trials with errors and excluding reaction times below 200 ms and more than two standard deviations above the patient's mean. This resulted in a data loss of 4.9%.

An AB score was obtained for each patient, and each pair of alcohol-control pictures by subtracting the response latency when the probe and the alcohol picture were in different positions

from the response latency when the probe was at the same location as the alcohol picture (Lubman, Peters, Mogg, Bradley, & Deakin, 2000). Positive scores indicated an increase in the time needed to detect the probe when it did not appear in the same location as the alcohol picture. We estimated the quality of our model's fit using Akaike's Information Criterion (AIC). We estimated the percentage of variance explained by the relationship between the dependent variable and a set of predictors using the package MuMIn (Barton, 2020): the marginal  $R^2$  estimates the amount variance explained by fixed factors; the conditional  $R^2$  estimates the amount of variance explained by both fixed and random factors. We addressed the problem of multiple tests by comparing p values obtained in our models with adjusted p values (Holm-Bonferroni stepwise method). Unadjusted p values must be below their related, adjusted p values to be significant.

#### 3. Results

The first model (AIC=-1877.54) revealed that post-task VASC scores were significantly higher than pre-task measures (B=.08; p<.001). (marginal  $R^2$ =.003, conditional  $R^2$ =.956). The five metacognitions were added in a second series of models. The first (AIC=-1869.44, marginal  $R^2$ =.03) revealed a non-significant effect of MCQ1 (B=-01; p=.27). The second (AIC=-1875.83, marginal  $R^2$ =.18), third (AIC=-1875.52, marginal  $R^2$ =.15,) and fourth models (AIC=-1878.57, marginal  $R^2$ =.21) revealed significant effects of MCQ2 (B=.03; p=.01), MCQ3 (B=.04; p=.01) and MCQ4 (B=0.06; p=.003), respectively. The fifth model (AIC=-1871.19, marginal  $R^2$ =.01) revealed a non-significant effect of MCQ5 (B=.02; p=.54). We therefore retained MCQ2, MCQ3 and MCQ4 for subsequent analyses.

We added the interaction *Metacognitions\*Time* to our third series of models (table 2). The model incorporating MCQ2 (AIC=-2144.08, marginal  $R^2$ =.18) revealed a significant effect of *MCQ2\*Time* on craving (*B*=.01; *p*<.001). Similarly, the model incorporating MCQ3 (AIC=-1949.57, marginal  $R^2$ =.15) revealed a significant interaction *MCQ3\*Time* (*B*=.01; *p*<.001), and the model incorporating MCQ4 (AIC=-1963.26, marginal  $R^2$ =.22) revealed a significant interaction *MCQ4\*Time* (*B*=.01, *p*<.001). All main effects remained significant, and all significant effects were below their respective, adjusted *p* values.

Insert Table 2 about here

We tested a fourth series of models of craving that included AB - without random effect - in order to compare the magnitude of this effect with previously published results (Field et al., 2009). The objective of our research was to estimate the effect of AB on craving when adjusted for covariates and between-individual differences. We therefore next tested multivariate mixed-effects models with AB, a random-intercept effect and covariates. We reported a significant effect of AB on craving ( $B \le .001$ , p = .04) (AIC=5969.26, marginal  $R^2 = .002$ ) but a non-significant effect when the random effect was added ( $B \le .001$ , p = .99) (AIC=-1695.21, marginal  $R^2 \le .001$ , conditional  $R^2 = .953$ ). These results confirmed that our model adjustment to data was improved by accounting for the effect of between-individual differences on craving. We added the interaction Metacognitions\*AB in our models. The model incorporating MCQ2 (AIC=-2095.71; marginal  $R^2=.18$ ) revealed no significant AB (B<.001, p=.98) or MCQ2\*AB effects (B<.001, p=.98). The model incorporating MCQ3 (AIC=-1902.46, marginal  $R^2$ =.15) revealed non-significant AB (B<.001, p=.99) or MCQ3\*AB effects (B<.001, p=.97). Finally, the model incorporating MCQ4 (AIC=-1916.24, marginal  $R^2$ =.21) revealed non-significant AB (B<-.001, p=.99) or MCQ4\*AB effects (B<.001, p=.99). As the interaction *Metacognitions*\*AB increased the AIC compared to our third series of models, we discarded the fourth series.

## 4. Discussion

The repeated exposure to alcohol makes alcohol-related contextual factors more salient, and increases craving (Robinson & Berridge, 1993; Carter & Tiffany, 1999; Ghita et al., 2019). Accordingly, we found an increase in craving after completion of the DPDT. This result confirmed that our manipulation was effective. We reported a positive effect of AB on craving (Field et al., 2009), but this effect became non-significant when adjusted for patients' characteristics and metacognitions. The effects of metacognitions on craving were positive and significant, but they did not significantly moderate the effect of AB on craving.

We confirmed that some of the variance in AB and craving is shared (Robinson & Berridge, 1993), but their relationship would be explained by inter-individual differences. In this case, AB did not appear to be a significant predictor of craving (van Lier et al., 2018) but merely reflected the activation of controlled cognitive resources and metacognitions that enhance the initial stimulus, and help in coping with related thoughts and emotions (Kavanagh, Andrade, & May, 2005; Spada, et al., 2015). Metacognitions may bias the overall ability to control attention (Spada, Georgiou &

Wells, 2010) and craving correlates with AB when alcohol-related stimuli have been presented for 2000 ms (Field et al., 2004). Craving could therefore be associated with the maintenance of attention on stimuli rather than with biases in the shifting of attention. Our results may thus indicate that the activation of metacognitions can strengthen the voluntary focusing of attention on alcohol-related cues and thereby explain both the effect of AB on craving and the level of craving reported by our patients.

We confirmed an effect of generic metacognitions – specifically, negative beliefs about thoughts concerning uncontrollability and danger (MCQ2), cognitive confidence (MCQ3), and beliefs about the need to control thoughts (MCQ4) – on craving. These results were expected, as beliefs about the need to control thoughts are strong predictors of addictive behaviors, and prospectively predict relapse in alcohol use. Both cognitive confidence and negative beliefs about thoughts concerning uncontrollability and danger are also related to problem drinking (Spada & Wells, 2005; Hoyer, Hacker, & Lindenmeyer, 2007; Nosen & Woody, 2009, 2014; Hammonniere & Varescon, 2018).

Alcohol intoxication is thought to impair the neurological systems underlying metamemory judgments and reduce both cognitive confidence and the confidence in one's ability to control the desire to consume alcohol (Anton, 1999; Spada & Wells, 2005). It is therefore possible that metacognitions, and in particular lack of cognitive confidence increase the likelihood of using maladaptive coping strategies to manage craving-related thoughts, and the perception of an overwhelming desire to seek out alcohol when exposed to alcohol-related cues. Consistent with this idea, we found a significant, moderating effect of the three aforementioned metacognitions on the effect of the DPDT on craving.

Our findings provide experimental support in the application of Metacognitive Therapy (MCT) for the treatment of AUD. Indeed, a recently published case series on MCT for AUD has shown that this type of psychological treatment is effective in reducing alcohol use and leads to changes in metacognitions (Caselli, Martino, Spada, & Wells., 2018).

Metacognitions appear to be relevant in evaluating the personal relevance of a situation (Matthews & Junke, 2006), and they are likely to activate maladaptive coping strategies in the form of rumination, worry and desire thinking which will exacerbate craving (Caselli et al., 2018).

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Consequently, patients with AUD who hold maladaptive metacognitions appear to be at greater risk of using unhelpful strategies to manage craving that may potentially exacerbate it. As patients were recruited in a controlled, post-withdrawal context, where no alcohol was available, our results support the hypothesis that metacognitive control is enhanced by sustained attention to the goal of controlled drinking. The latter observation raises the question of whether AUD patients who hold string maladaptive metacognitions may be less likely to accept abstinence as a treatment goal, and may benefit more from a pragmatic goal of controlled drinking (Connor, Haber, & Hall, 2016) to reduce the risk of post-treatment relapse.

To the best of our knowledge, this study is the first to find evidence showing that the correlation between AB and craving is, in fact, explained by confounding variables including metacognitions. The latter observation may underlie a spurious association between AB and craving and could explain the lack of consensus regarding its magnitude. Our results support the rejection of AB as a parameter in the theoretical craving framework (van Lier et al., 2018).

#### 5. Conclusion

Our results call into question the validity of the hypothesis that craving can be explained by AB towards alcohol cues, and instead suggests that craving and AB are two outcomes of a common metacognitive activity. Our study has some limitations. The size of our sample is modest, and our research should be replicated with a larger sample size. The magnitude of the relationship between AB and craving is higher for illicit drugs or caffeine than for alcohol (Field et al., 2009). We can wonder if the effect of AB on craving, and the moderating effect of metacognitions, may be more robust for drugs other than alcohol. AB could be an output of the patient's current motivational state, strengthened by environmental factors (Christiansen, Schoenmakers, & Field, 2015). We recruited AUD inpatients who had been admitted to a rehabilitation center. The reduction in alcohol intake or abstinence were the two main treatment goals. In this context, it is reasonable to ask whether AB would predict craving and activate metacognitions, among patients with AUD who are living in a context where alcohol is immediately available. We assumed that metacognitions would moderate the effect of AB on craving, but Field and Cox (2008) assumed a bidirectional relationship between AB and craving. Craving would trigger metacognitions in turn 'launching' rumination, worry and desire thinking as means of monitoring and processing alcohol-related cues (Spada et al., 2015). The magnitude of AB could also be explained by an individual's coping styles, and we can

therefore wonder if rumination, worry and desire thinking may mediate the effect of craving on AB. Negative beliefs about thoughts concerning danger and uncontrollability, and cognitive confidence, have been found to correlate with attention shifting and the flexible control of thought in a sample of regular gamblers (Spada & Roarty, 2015). We can, therefore surmise that in the context of alcohol-related cues, AB will increase in patients with AUD who hold such metacognitions. However, the effect of the interaction *Alcohol-related cues\*Metacognitions* on AB was beyond the scope of this research, and this hypothesis needs further investigation.

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## Table1.

Participants' demographic and clinical characteristics.

	Mean	Standard Deviation
Demographic characteristics		
Age (years)	51.13	9.79
Education (years)	11.75	2.11
<i>Time of abstinence (days)</i>	12.66	6.34
Duration of the problem (years)	16.18	11.18
Neuropsychological assessments		
Montreal Cognitive Assessment		
Global score	24.73	2.85
Trail Making Test (TMT)		
TMTA (secs)	45.55	16.76
TMT B (secs)	103.08	52.44
TMT B-A (secs)	57.62	42.61
Stroop test		
<i>Time of completion Part C (secs)</i>	67.13	27.08
Psychopathological assessments		
Obessive Compulsive Disorder Scale		
Obsessions	9.16	4.33
Compulsivity	12.62	3.90
Global score	23.06	7.57
Metacognitive Questionnaire		
Positive beliefs about worry	39.26	12.12
Negative beliefs about thoughts concerning uncontrollability		
and danger	40.39	10.08
Cognitive confidence	20.28	6.67
Beliefs about the need to control thoughts	28.16	6.25
Cognitive self-consciousness	19.08	3.28
UPPS-P impulsive behavior scale		
Negative urgency	33.67	6.49
Lack of premeditation	20.87	4.33
Lack of perseverance	18.08	4.31
Sensation seeking	30.05	7.49

## Table 2.

Fixed effects						Random effect (intercept)	
	В	SE	CR	Р	Adjusted p values	Variance	SD
Model with MCQ2	-	-	-	-	-	.46	.68
Time	03	.02	-3.34	<.001	.001	-	-
MCQ2	.03	.01	2.38	.02	.05	-	-
MCQ2*Time	.01	.006	17.30	<.001	.025	-	-
Model with MCQ3	-	-	-	-		.48	.70
Time	01	.02	-4.77	<.001	.001	-	-
MCQ3	.04	.02	2.33	.03	.05	_	_
MCQ3*Time	.01	.001	2.33	<.001	.025	-	-
Model with MCQ4	-	-	-	-		.44	.66
Time	0.03	.01	3.34	<.001	.001	-	-
MCQ4	.05	.02	2.93	.006	.05	-	-
MCQ4*Time	.01	.001	10.03	<.001	.025	-	-

Parameters used in models for craving incorporating the interaction "Time\*Metacognitions" effects.

Note: *B*= Unstandardized regression coefficient; CR= critical ratio; MCQ2= negative beliefs about thoughts concerning uncontrollability and danger; MCQ3= cognitive confidence; MCQ4=beliefs about the need to control thoughts.