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REFLECTIVE AND IMPULSIVE PROCESSES IN ADDICTION AND THE ROLE OF MOTIVATION

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This chapter focuses on the role of motivation in the Reflective and Impulsive Model (RIM) (Strack & Deutsch, 2004), and related dual process models, with an emphasis on addiction. We will first consider motivational processes in the RIM and related dual-process models of addiction, then review studies assessing aspects of these models, including assessment and intervention studies. In the next section we discuss theoretical issues with dual process models and the role of motivation in these models, and discuss some alternatives. We end with our current perspective on the role of cognitive-motivational processes in addiction.

Cognitive-Motivational Processes in the RIM and Related Models

In their landmark paper presenting the RIM, Strack and Deutsch (2004) start from the centuries old observation that people do not always behave in ways that reflect their values, the phenomenon of *akrasia* (see also Friese & Hofmann, Chapter 9). Addiction has struck many as a prototypical example, where knowledge of the benefits of quitting is often not enough to do so (Deutsch & Strack, 2006; Stacy & Wiers, 2010). The RIM and related dual process models explain this phenomenon by positing two classes of psychological processes, which under normal circumstances work together to guide behavior in an adaptive way, but in addiction have lost balance, with automatically-triggered impulsive processes overwhelming reflective considerations, leading to continued addictive behavior, even in the face of severe negative consequences. While RIM was primarily based on social psychological research, at the same time neuroscientists in addiction developed conceptually similar models, linking functions to brain circuits (Bechara, 2005; Stacy et al., 2004; Volkow et al., 2004).

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What role does motivation play in the RIM? In the RIM, motivation is integrated both into the impulsive system, in the form of motivational orientation (approach or avoid), and in the reflective system, quoting Smith and DeCoster (2000): "rule-based processing draws on symbolically represented rules [. . .] that are structured by language and logic [. . .] and can be learned in just one or a few experiences [. . . and] *occurs optionally when capacity and motivation are present*." (Strack & Deutsch, 2004, p. 221, italics added). This last statement refers to a type of motivation that is different from motivational orientation: the motivation to override or inhibit an impulsive or automatically triggered response tendency (see also Fazio, 1990).

Given the crucial importance of this motivation to override appetitive response tendencies in addiction (e.g., Miller, 2008), in their RIM-inspired dual-process model of addiction, Wiers, Stacy and colleagues (Wiers & Stacy, 2006; Wiers et al., 2007), emphasized that individual differences in the impact of impulsive processes in addiction depend both on individual differences in ability (strength of different executive functions) and in motivation to override impulsive appetitive tendencies (see Hofmann et al, 2008a; 2009 for conceptually similar models on health behaviors and self-control). For the case of addiction, two feedback loops were included from the addictive behavior to these processes: a positive feedback loop to the impulsive processes involved and a negative feedback loop to the ability and motivation to control (Wiers et al., 2007). First, impulsive processes were hypothesized to become stronger as a result of the addictive behavior, resulting in an attentional bias for substance-related cues, an associative memory bias for effects associated with the addictive behavior, and a bias in approach action tendencies. Second, both ability and motivation to control impulses were hypothesized to become weaker as a result of alcohol or drug use, with specific negative effects associated with specific drugs (see Fernandez-Serrano et al., 2011, for a review).

Evidence Regarding Cognitive-Motivational Processes in Addiction

A series of studies investigated the moderating effects of individual differences in executive functions in the prediction of addictive behaviors by impulsive processes. Studies in high-risk adolescents usually confirmed the predicted pattern: Grenard and colleagues (2008) found that spontaneous substance-related (alcohol/cigarette smoking) memory associations (Stacy, 1997), better predicted subsequent alcohol and cigarette smoking behavior in adolescents with relatively poor working memory (WM) than in adolescents with relatively good WM. Thush and colleagues (2008) found a similar pattern using an Implicit Association Test (IAT) (Greenwald et al., 1998): in adolescents with relatively poor WM, positive and arousal associations with alcohol were predictive of use and problems, but these associations were not predictive in high-WM adolescents (Thush et al., 2008).

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Similarly, Peeters and colleagues found that automatically triggered approach-tendencies for alcohol were predictive of escalation of use in young externalizing adolescents (primarily boys) with relatively weak inhibitory control abilities (Peeters et al., 2013). However, these interactions were not found in general population samples of adolescents (Janssen et al., 2015; Pieters et al., 2014, for a review of the work in adolescents, see Wiers, Boelema, et al., 2015). Similar interactions have been studied in young adults, typically undergraduate students, regarding alcohol use and problems (e.g. Houben & Wiers, 2009), aggression after alcohol (Wiers, et al., 2009a), and various other non-substance-related behaviors (Hofmann et al., 2008b). In an interesting study in the domain of eating, Hofmann and colleagues (2009) found evidence for unique moderating effects of different executive functions. A recent as-yet unpublished meta-analysis on the interaction of executive functions and implicit processes across health behaviors found evidence for a small but significant interaction across studies (Ames et al., 2015). In summary, there is empirical support for the hypothesis from dual process models in addiction, that automatically triggered or impulsive processes are better predictors of addictive behaviors in individuals with relatively weak executive functions, with the stronger evidence coming from at-risk samples. However, all of these studies disregarded motivation to control. What do we know of the role of motivation to control in addictive behaviors?

To our knowledge, four studies have directly investigated the role of motivation to control in the prediction of addictive behaviors by implicit or impulsive processes. Ostafin and colleagues (2008) gave participants an approach-avoid alcohol IAT (Ostafin & Palfai, 2006), and elicited motivation to restrain drinking by instructing them that greater consumption would impair performance on a later task in which they could win a prize. All participants viewed aversive slides and then completed a thought-listing task. Participants were either instructed to exert self-control by suppressing negative affect and thoughts regarding the slides or not. During the subsequent taste test, participants who suppressed their negative affect ("ego depletion") (Baumeister, 2003, but see Inzlicht et al., 2014) consumed more alcohol during a taste-test than did those in the control group. The IAT, but not an explicit measure of alcohol motivation, more strongly predicted alcohol use after emotion suppression.

Tahaney and colleagues (2014), tested hazardous drinking in young adults, who were exposed to the sight and smell of an alcoholic beverage that they anticipated consuming, for which urge and anticipated stimulant effects were measured. The interaction between the strength of individuals' executive functions and each of the appetitive response ratings was predictive of participants' drinking behavior, in participants high in drinking restraint, but not in participants low in drinking restraint. Interestingly, among participants high in restraint and executive functions, higher anticipated stimulation ratings were associated with *reduced* drinking, consistent with theories of counteractive self-control (Myrseth & Fishbach, 2009). These results suggest that some individuals with high restraint

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goals might actually drink *less* as a result of higher temptation experiences if their executive functions successfully trigger self-control efforts. Hence, successful self-control appears to depend on two processes: the detection of the conflict, and the availability of control strategies (Myrseth & Fishbach, 2009).

Sharnabee and colleagues (2013) tested the interaction of appetitive action tendencies and the ability to exert control over these tendencies as a function of whether tasks required control for successful completion. Social drinkers who differed in their self-reported ability to regulate their drinking completed a variant of the alcohol Approach-Avoidance Task (AAT, Wiers et al., 2009b), in which approach and avoid trials were assessed separately. Group differences in performance were only observed on trials that required an avoidance movement (incongruent with an approach tendency), and these were moderated by individual differences in WM, such that problem drinkers with lower WM showed greater behavioral bias toward alcohol than those with higher WM.

Finally, a recent study by Van Deursen and colleagues (2015) assessed automatically triggered appetitive memory associations, ability to control (WM and interference control) and motivation to change, in problem drinkers who wanted to reduce their drinking with internet-delivered training-tasks. Results partially supported the hypothesized interplay between memory associations, executive functions, and motivation to change: motivation to change moderated the interaction between valence associations and WM-capacity in the prediction of (heavy) alcohol use. WM-capacity moderated the relationship between valence associations and drinking in individuals with strong motivation, but not in those with weak motivation to change. In those with strong motivation but low WM capacity, positive associations were associated with higher alcohol use. In individuals with both strong motivation and high WM capacity, positive associations were unrelated to alcohol use. However, this pattern was not found for the other executive function task (classical Stroop) or for approach associations.

Together these studies indicate that indeed the combination of ability to control impulses (various executive functions) and the motivation to change or restrain consumption are important in predicting the impact of relatively automatic processes in addiction and related problems.

Changing Cognitive Processes in Addiction and the Role of Motivation

Once the impact of relatively automatic or impulsive processes in the prediction of addictive behaviors became evident, in addition to more reflective expectancies and motivations to drink (e.g., Stacy, 1997; Wiers et al., 2002; meta-analysis: Rooke et al., 2008), a logical next step was to attempt to directly change these processes, as had been pioneered in anxiety research (MacLeod et al., 2002). Directly manipulating psychological processes hypothesized to play a role in psychopathology was first a test of these models: the best way to establish causality

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is to directly manipulate variables (in both directions, e.g., train non-addicted people either toward or away from alcohol; see also Field & Eastwood, 2005; Wiers et al., 2010). Second, once it became evident that directly manipulating relevant psychological processes was possible, clinical applications were tested, a field now known as Cognitive Bias Modification (CBM, for a review, see Wiers et al., 2013). This is typically done with an adapted version of a related assessment task. For example, Wiers, Rinck and colleagues (2009b), developed an irrelevant-feature alcohol approach-avoidance task, in which participants push or pull a joystick in response to a contents-irrelevant feature of the stimulus, e.g. participants make a push-movement in response to pictures in landscape-format and a pull-response to pictures in portrait format. The task contains a zoom-feature (Neumann & Strack, 2000), which creates a sense of approach upon a pull-movement (picture-size increases) and of avoidance upon a push-movement (picture-size decreases). Heavy drinkers were found to faster pull than to push alcohol-pictures, indicating an automatically triggered approach bias, which was genetically moderated by the OPRM1 gene (also related to cue-induced craving). Similarly, heavy cannabis smokers demonstrated an approach-bias for cannabis-related stimuli, not found in non-smokers, and the approach-bias in the heavy users predicted subsequent escalation of use in the half year to follow (Cousijn et al., 2011). Following the logic of attentional re-training (MacLeod et al., 2002), and in collaboration with Fritz Strack, a manipulation version was developed (Wiers et al., 2010). Students were randomly allocated to a condition in which the original alcohol AAT [Approach Avoidance Task] (assessment) changed into a version in which 90 percent of the alcohol-pictures came in the format that was to be pushed (avoid-alcohol condition), or a version in which 90 percent of the alcohol-pictures came in the format that was to be pulled (approach-alcohol condition). This manipulation changed their dominant action tendencies in the direction congruent with the training, with some congruent effects on drinking behavior: in a taste-test, heavy drinkers who were successfully trained to avoid alcohol drank less than heavy drinkers who were successfully trained to approach alcohol. It is an interesting as-yet unanswered question to what extent the actual avoid movement (arm flexion) is important or if symbolic avoidance suffices (Krieglmeyer et al., 2011; Strack et al., 1988).

When considering the role of motivation, it is important to distinguish between CBM studies in which cognitive processes were manipulated in participants who were not motivated to change their addictive behavior (typically students participating for course credit), and studies in which participants were motivated to change their addictive behaviors (typically patients in treatment). Results in non-motivated samples have generally been negative or modest. For example, several studies attempted to change an attentional bias for alcohol in heavy drinking students, in a single session of training, and found an effect on attentional bias only on trained stimuli, not on untrained stimuli or behavior (Field et al., 2007; Schoenmakers et al., 2007). A recent study in smoking illustrates

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this: Kerst and Waters (2014) randomly assigned smokers who did not desire to quit to a training or control group (continued assessment), and found that attentional re-training changed the attentional bias as well as cue-induced craving, in the absence of effects on smoking. Similarly, Lindgren and colleagues found no effects of two sessions of approach-bias re-training, in students with no motivation to change (Lindgren et al., 2015). Hence, CBM studies in participants unmotivated to change generally resulted either in no change of behavior or small short-term effects on behavior (Houben et al, 2011a; Wiers et al., 2010).

More positive results were found in participants who are motivated to change their behavior. Fadardi and Cox (2009) reported that attentional control training helped problem-drinkers reduce their drinking, and increased their motivation to change. Although conceptually interesting, interpretation of the findings is compromised by the lack of a control group. Schoenmakers and colleagues (2010) found that supplementing treatment with five sessions of attentional re-training vs. placebo-training decreased attentional bias for alcohol, and showed effects on treatment outcome. Wiers and colleagues (2011) tested the effects of four sessions of approach-bias re-training, compared with placebo-training (or no training) as a supplement to regular treatment, and found effects on the approach-bias for alcohol (which changed into an avoidance bias in the training group only), which also generalized to an approach-avoidance IAT. Moreover, relapse one year after treatment discharge was reduced in the training-group compared with the control groups. Although initial analyses did not confirm mediation of the treatment outcome effect by the change in bias, analyses of different stimulus categories in the IAT did show mediation of the clinical effect, by the change in alcohol-avoidance bias (Gladwin et al., 2015). In a replication study (*N* = 509; Eberl et al., 2013), the effect of CBM on clinical outcome one year later was replicated, mediated by change in approach-bias. Moreover, moderation was found, indicating that especially patients with a strong approach-bias profited from the training. Hence, clinical studies in which CBM has been added to treatment as usual, have consistently demonstrated positive effects, which contrasts with the largely negative findings in unmotivated participants.

Given the fact that CBM consists of computerized training, which can be provided over the internet, a logical follow-up question was whether training could be effective without further clinical support. Houben and colleagues (2011b) tested the effects of internet-delivered WM-training on drinking behavior, and found that drinking was more strongly reduced in the adaptive training condition compared with the easy and non-adaptive control-training condition, in those participants with relatively strong positive alcohol-associations. Although motivation was not directly assessed, participants' high scores on the index of alcohol-related problems and their endurance (25 sessions of training), suggests a high motivation to change. In a study comparing different forms of alcohol-CBM, Wiers and colleagues (Wiers, Houben, et al., 2015) found that participants in all conditions, including the placebo-training condition successfully

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reduced drinking. Hence, the differential effects of real compared with control-training found in patients (Eberl et al., 2013; Schoenmakers et al., 2010; Wiers et al., 2011), were not replicated. This could be related to the different goal (reduction vs. abstinence) and/or to the lack of motivational support in the internet-only training-study. In an ongoing study (protocol: Van Deursen et al., 2013), we therefore added a minimal online motivational intervention to the training. We now differentiate between different types of motivation relevant in treatment: motivation to change the addictive behavior, and motivation to do training as a means to change the behavior (Boffo et al., 2015). The latter distinction is also relevant in relation to adding game elements to training: while this likely increases motivation to train, it does not by itself change motivation to change the targeted behavior (Boendermaker et al., 2015).

In conclusion, both in assessment and in CBM, there is evidence that the interplay between three components is crucial: strength of executive functions, motivation to control and relatively automatic appetitive processes. The next question is how this can best be modeled, and related to underlying neurocognitive processes.

Theoretical Issues: Motivation and Neurocognitive Processes

Dual process models such as RIM have recently been strongly criticized, and it has even been suggested that they may hinder rather than help scientific progress (Keren, 2013). For instance, arguments have been made against a clear dichotomy between reflective and impulsive systems or processes (Bargh, 1994; Keren & Schul, 2009), the evidence for separable neural systems has been argued to be lacking (Keren & Schul, 2009), and the definition and role of theoretical concepts has been argued to need further precision (Keren & Schul, 2009; Gladwin et al., 2011). We do not see these criticisms as fatal, but as an impetus to improve dual process models. For instance, in our Reinforcement and Reprocessing model of Reflectivity (R^3) (Gladwin et al., 2011, section 5; Gladwin & Figner, 2014; Wiers et al, 2013), impulsivity and reflectivity are defined as emergent states, based on three theoretical principles. First, following general models of reinforcement, we emphasize the circuit structure of the brain in response selection: Cortical regions, including prefrontal cortex, and the basal ganglia function as a loop, not as opposing systems (Bunge, 2004; Seger, 2008; Van Hecke et al., 2010; Vink et al, 2013). Fundamental concepts such as top-down biasing (Schneider & Chein, 2003), re-entrance (Edelman & Gally, 2013) or reprocessing (Cunningham et al, 2007) provide a second building block. Essentially, the effect of a stimulus on the brain develops over time within the seconds after its presentation due to iterations of processing applied to it, thus for instance changing its evaluation (Cunningham et al., 2007). Third and finally, executive functions must be considered part of the general response selection loop: They are selected as an optimal (cognitive)

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response by the reinforcement loop, connecting control to motivation (Norman & Shallice, 1986; Hazy, Frank, & O'Reilly, 2006; Kouneiher, Charron, & Koechlin, 2009; Pessoa, 2009). With these underlying neuroscientific principles, parallel response-selection loops with different time courses can be seen to result in either impulsive or reflective states. If the system is provided less time to converge on an optimal selection, it will provide fast responses that win response competition early in the process, based on simple, heuristic information processing. Given more time, more deliberative processes can evolve, or those using slower, more sophisticated elaboration or prediction of the future (cf. Volkow & Baler, 2015, for a sketch of different neurocognitive networks involved), or requiring functions that are inherently delayed such as inhibition of a previously activated response.

Thus, we retain the distinction between observed reflective and impulsive behavior, but in terms of differing global states with common underlying processes. This view of reflective versus impulsive states may help connect cognitive models and information from neuroimaging studies. For instance, CBM for alcoholism has been shown to affect amygdala reactivity to alcohol cues (C. E. Wiers et al., 2015); while this could be generally understood in terms of automatic salience attribution, perhaps more detailed models will show how this affects components of the response selection loop when confronted with alcohol. The R^3 model predicts that temporal dynamics play a central role in biases in general (Gladwin, Mohr, & Wiers, 2014), and indeed alcohol-related attentional biases are strongly dependent on the precise delay between cues and stimuli (Noë l et al., 2006; Townshend & Duka, 2007). Thus, while we acknowledge the criticisms of dual process models, we conclude that an alternative view, focusing in particular on conceptually separating global states and common underlying processes, may address theoretical concerns and suggest fruitful lines of future research.

Alternative Models

Regarding addiction, there are two prominent classes of alternative models that contrast RIM-type dual process models: psychological uni-models with an emphasis on competing motivational processes (Kö petz et al., 2013), and neurobiological models emphasizing a distinction between incentive motivational processes and habitual processes (Everitt & Robins, 2005).

Unimodels explain the problem of *akrasia* (behaviour apparently against people's self-interest), by postulating a single cognitive system in which multiple conflicting goals can be activated in a specific situation (Kö petz et al., 2013; Stroebe et al. 2013). Goals are defined as cognitive representations of desirable outcomes, interconnected with other goals and means of attainment (Kruglanski et al., 2002). In a strong form of the theory, only propositional goal-related information influences human behaviour (De Houwer, 2013). A number of general

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principles have been found to underlie motivated behaviours, such as accessibility (goals can be spontaneously activated), interconnectedness (activated goals activate means of attainment), goal-shielding (which may lead to inhibition of alternative goals), and emotional transfer from goal to means (e.g., when a cigarette is smoked to relax, the cigarette becomes associated with relaxation, even though it physiologically activates stress-reactions). Hence, the general point in this perspective is that many seemingly irrational behaviours in this domain (examples of *akrasia*), may in fact be examples of outcomes of goal-directed processes. While we acknowledge that some seemingly irrational behaviors in this domain may be understood from this competing goals perspective, we also maintain that in addictive behaviours, strong cue-elicited reactions play an important role, especially in people suffering from addictions who have either a weak ability or motivation to control these impulses.

Incentive habit models are based on animal research into learning processes underlying action control (Balleine & O'Doherty, 2010; De Wit & Dickinson, 2009; Everitt & Robins, 2005). This line of research distinguishes between goal-directed actions, driven by response-outcome (R-O) associations, and responses driven by stimulus-response (S-R) associations, where a stimulus leads to a response, no matter what the expected outcome is. After extensive repetition, behaviour can become insensitive to expected outcomes, which is interpreted as a transfer from control from R-O associations to S-R associations. This has been demonstrated in devaluation studies, in which a response becomes devaluated (either by not resulting in reward anymore, or by pairing the response to a negative outcome such as nausea or foot-shocks, see for a review De Wit & Dickinson, 2009). While behavior is normally discontinued after devaluation, after extensive repetition this is no longer the case, indicating the development of habitual or compulsive responding. This perspective has been related to the development of drug addiction: some rats develop such a strong habitual response to cues for cocaine that they keep on responding even when this leads to foot-shocks (and no cocaine), a pattern typically not seen for sugar (Vanderschuren & Everitt, 2004). Hence, models in this line of research are different from RIM-like dual process models, because they distinguish between motivational and habitual responses, which have become insensitive to changes in motivational value, while in the RIM and related models, impulsive processes consist of both habitual and automatically triggered motivational responses. Distinguishing between these two different types of relatively automatic or impulsive processes (cue-driven automatically triggered motivational responses and habitual non-motivational responses) could provide an important way forward.

Conclusions

The RIM has been very influential in psychological research into cognitive-motivational processes in addiction. A large number of studies confirmed the

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hypothesized interaction between executive functions and implicit or impulsive cognitive-motivational processes in the prediction of addictive behaviors, with the strongest results in high-risk individuals. In addition to the *ability* to control impulsive tendencies (strength of different executive functions), motivation to do so appears to be important, both in the prediction of addictive behaviors, and in training studies demonstrating clinically relevant training effects only in people motivated to change. While motivation to override an impulse is mentioned in the original exposition of the RIM (see citation above), the role of this construct in the RIM and related models is less clear and can easily lead to models containing a "motivational homunculus". We believe that grounding future models in cognitive neuroscience is important, and can help prevent this problem and drive theory forwards. As illustrated in the R^3 model (Gladwin et al., 2011), the concept of motivation can be translated into parallel recursive response-selection loops from which either impulsive or reflective behavior can emerge. In addition, research into mechanisms underlying reward learning has indicated that habitual responses (occurring whenever triggered by an eliciting stimulus, even after devaluation) should be distinguished from automatically triggered motivational responses. Moreover, at least some of the seemingly irrational processes in addiction may be understood from complex goal-directed motivational processes (Kö petz et al., 2013), although we believe that automatically triggered appetitive processes still play an important role in addictive behaviors in a subgroup of people (with relatively weak control functions and/or motivation to control).

In conclusion, research inspired by the RIM has led to significant advances in addiction theory and interventions such as CBM. The currently most important questions for further research appear to involve individual differences which modulate effects of impulsive processes and the efficacy of re-training. Motivation seems to play a central role in these questions, which will we hope also motivate next steps in the development of theory.

References

Ames, S. L., Xie, B., Aragon, J. & Stacy, A. W. (2015). Moderating Effects of Control Functions on Implicit Cognitive Processes in Health Behavior: A Meta-Analysis. Unpublished Ms.

Balleine, B. W. & O'Doherty, J. P. (2010). Human and rodent homologies in action control: corticostriatal determinants of goal-directed and habitual action. *Neuropsychopharmacology, 35*, 48–49.

Bargh, J. A. (1994). The Four Horsemen of Automaticity: Awareness, Intention, Efficiency and Control in Social Cognition. In R. Wyer & T. Srull (Eds.), *Handbook of Social Cognition* (2nd ed., pp. 1–40). Hillsdale, NJ: Erlbaum.

Baumeister, R. F. (2003). Ego depletion and self-regulation failure: a resource model of self-control. *Alcoholism: Clinical and Experimental Research*, *27*, 281–284.

Bechara, A. (2005). Decision making, impulse control and loss of willpower to resist drugs: a neurocognitive perspective. *Nature Neuroscience*, *8*(11), 1458–1463.

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6870P REFLECTIVE BEHAVIOUR-A/lb_New supps Royal Combo ligs US 6 x 9 01/06/2016 17:25 Page 183

Boffo, M., Pronk, T., R. W. Wiers, & Mannarini, S. (2015). Combining cognitive bias modification training with motivational support in alcohol dependent outpatients: study protocol for a randomised controlled trial. *BMC Trials*, *16*, 63.

Boendermaker, W. J., Prins, P. J. M, & Wiers, R. W. (2015). Cognitive Bias Modification for Adolescents with Substance Use Problems – Can Serious Games Help? *Journal of Behavior Therapy and Experimental Psychiatry*, *49*, 13–20.

Bunge, S. A. (2004). How we use rules to select actions: A review of evidence from cognitive neuroscience. *Cognitive, Affective, & Behavioral Neuroscience*, *4*(4), 564–579. http://doi.org/10.3758/CABN.4.4.564

Cousijn, J., Goudriaan, A. E., & Wiers, R. W. (2011). Reaching out towards cannabis: Approach_bias in heavy cannabis users predicts changes in cannabis use. *Addiction*, *106*(9), 1667–1674.

Cunningham, W. A., Zelazo, P. D., Packer, D. J., & Van Bavel, J. J. (2007). The Iterative Reprocessing Model: A Multilevel Framework for Attitudes and Evaluation. *Social Cognition*, *25*(5), 736–760.

De Houwer, J. (2013). A propositional model of implicit evaluation. *Social and Personality Psychology Compass*, *8*, 342–353.

De Wit, S. & Dickinson, A. (2009). Associative theories of goal-directed behaviour: a case for animal–human translational models *Psychological Research*, *73*, 463–476.

Deutsch, R. & Strack, F. (2006). Reflective and impulsive determinants of addictive behavior. In R. W. Wiers & A. W. Stacy (Eds.), *Handbook of implicit cognition and addiction*. (pp. 45–57). Thousand Oaks, CA: SAGE.

Eberl, C., Wiers, R. W., Pawelczack, S., Rinck, M., Becker, E. S., & Lindenmeyer, J. (2013). Approach bias modification in alcohol dependence: Do clinical effects replicate and for whom does it work best? *Developmental Cognitive Neuroscience*, *4*, 38–51.

Edelman, G. M., & Gally, J. A. (2013). Reentry: a key mechanism for integration of brain function. *Frontiers in Integrative Neuroscience*, 7, 63. http://doi.org/10.3389/fnint.2013.00063

Evans, J. S. B. T. (2008). Dual-processing accounts of reasoning, judgment, and social cognition. *Annual Review of Psychology*, *59*, 255–278.

Everitt, B. J., & Robbins, T. W. (2005). Neural systems of reinforcement for drug addiction: From actions to habits to compulsion. *Nature Neuroscience*, *8*, 1481–1489.

Fadardi, J. S., & Cox, W. M. (2009). Reversing the sequence: reducing alcohol consumption by overcoming alcohol attentional bias. *Drug and Alcohol Dependence*, *101*(3), 137–145.

Fazio, R. H. (1990). Multiple processes by which attitudes guide behavior: The MODE model as an integrative framework. In M. P. Zanna (Ed.), *Advances in experimental social psychology* (Vol. 23, pp. 75–109). San Diego, CA: Academic Press.

Fernandez-Serrano, M. J., Perez-Garcia, M., & Verdejo-Garcia, A. (2011). What are the specific vs. generalized effects of drugs of abuse on neuropsychological performance? *Neuroscience and Biobehavioral Reviews*, *35*, 377–406.

Field, M., Duka, T., Eastwood, B., Child, R., Santarcangelo, M. & Gayton, M. (2007). Experimental manipulation of attentional biases in heavy drinkers: do the effects generalise? *Psychopharmacology*, *192(4):* 593–608.

Field, M., & Eastwood, B. (2005). Experimental manipulation of attentional bias increases the motivation to drink alcohol. *Psychopharmacology*, *183*, 350–357.

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*

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6870P REFLECTIVE BEHAVIOUR-A/lb_New supps Royal Combo ligs US 6 x 9 01/06/2016 17:25 Page 184

Psychology Series: Neuroeconomics, Judgment and Decision Making (pp. 157–180). New York: Psycholoy Press.

Gladwin, T. E., Figner, B., Crone, E. A., & Wiers, R. W. (2011). Addiction, adolescence, and the integration of control and motivation. *Developmental Cognitive Neuroscience*, *1*(4), 364–376.

Gladwin, T. E., Mohr, S. E., & Wiers, R. W. (2014). The Potential Role of Temporal Dynamics in Approach Biases: Delay-dependence of a General Approach Bias in an Alcohol Approach-Avoidance Task. *Emotion Science*, *5*, 1398.

Gladwin, T. E., Rinck, M., Eberl, C., Becker, E. S. Lindenmeyer, J., & Wiers, R. W. (2015). Mediation of Cognitive Bias Modification for Alcohol Addiction via Stimulus-specific Alcohol Avoidance Association. *Alcoholism: Clinical and Experimental Research*, *39*(1), 101–107.

Greenwald, A. G., McGhee, D. E., & Schwartz, J. L. K. (1998). Measuring individual differences in implicit cognition: the Implicit Association Test. *Journal of Personality and Social Psychology*, *74*, 1464–1480.

Grenard, J. L., Ames, S. L., Wiers, R. W., Thush, C., Sussman, S. & Stacy, A. W. (2008). WM Moderates the Predictive Effects of Drug-Related Associations. *Psychology of Addictive Behaviors*, *22*, 426–432.

Hazy, T. E., Frank, M. J., & O'Reilly, R. C. (2006). Banishing the homunculus: making WM work. *Neuroscience*, *139*(1), 105–18.

Hofmann, W., Friese, M., & Roefs, A. (2009). Three ways to resist temptation: The independent contributions of executive attention, inhibitory control, and affect regulation to the impulse control of eating behavior. *Journal of Experimental Social Psychology*, *45*(2), 431–435.

Hofmann, W., Friese, M., & Wiers, R. W. (2008). Impulsive versus reflective influences on health behavior: A theoretical framework and empirical review. *Health Psychology Review*, *2*, 111–137.

Hofmann, W., Gschwendner, T., Friese, M., Wiers, R. W., & Schmitt, M. (2008b). WM capacity and self-regulation: Toward an individual differences perspective on behavior determination by automatic versus controlled processes. *Journal of Personality and Social Psychology*, *95*, 962–977.

Houben, K. & Wiers, R. W. (2009). Response Inhibition Moderates the Relationship between Implicit Associations and Drinking Behavior. *Alcoholism, Clinical and Experimental Research*, *33*, 626–633.

Houben, K., Nederkoorn, C., Wiers, R. W., &Jansen, A. (2011a). Resisting Temptation: Decreasing Alcohol-Related Affect and Drinking Behavior by Training Response Inhibition. *Drug and Alcohol Dependence*, *116*, 132–136.

Houben, K., Wiers, R. W., & Jansen, A. (2011b). Getting a grip on drinking behavior: Training WM to reduce alcohol abuse. *Psychological Science*, *22(7)*, 968–975.

Inzlicht, M., Schmeichel, B. J., & Macrae, C. N. (2014). Why self-control seems (but may not be) limited. *Trends in Cognitive Sciences*, *18*(3), 127–133.

Janssen, T., Larsen, H., Vollebergh, W. & Wiers, R. W. (2015). Longitudinal Relations between Cognitive Bias and Adolescent Alcohol Use. *Addictive Behaviors*, *44*, 51–57.

Keren, G. (2013). A Tale of Two Systems: A Scientific Advance or a Theoretical Stone Soup? Commentary on Evans & Stanovich (2013). *Perspectives on Psychological Science*, *8*(3), 257–262.

Keren, G., & Schul, Y. (2009). Two Is Not Always Better Than One: A Critical Evaluation of Two-System Theories. *Perspectives on Psychological Science*, *4*(6), 533–550.

1st PROOFS – NOT FOR DISTRIBUTION

6870P REFLECTIVE BEHAVIOUR-A/lb_New supps Royal Combo ligs US 6 x 9 01/06/2016 17:25 Page 185

Kerst, W. F., & Waters, A. J. (2014). Attentional retraining administered in the field reduces smokers' attentional bias and craving, *Health Psychology*, *33*(10), 1232–1240.

Kö petz, C. E., Lejuez, C. W., Wiers, R. W., & Kruglanski, A. W. (2013). Motivation and Self-Regulation in Addiction: A Call for Convergence. *Perspectives on Psychological Science*, *8*, 3–24.

Kouneiher, F., Charron, S., & Koechlin, E. (2009). Motivation and cognitive control in the human prefrontal cortex. *Nature Neuroscience*, *12*(7), 939–945.

Krieglmeyer, R., De Houwer, J., & Deutsch, R. (2011). How farsighted are behavioral tendencies of approach and avoidance? The effect of stimulus valence on immediate vs. ultimate distance-change. *Journal of Experimental Social Psychology*, *47*(3), 622–627.

Kruglanski, A. W., Shah, J. Y., Fishbach, A., Friedman, R., Chun, W. Y., & Sleeth-Keppler, D. (2002). A theory of goal systems. *Advances in Experimental Social Psychology*, *34*, 331–378.

Lindgren, K. P., Wiers, R. W., Teachman, B. A., Gasser, M. L., Westgate, E. C., Cousijn, J., Enkema, M., & Neighbors, C. (2015). Attempted Training of Alcohol Approach and Drinking Identity Associations in US Undergraduate Drinkers: Null Results from Two Studies. *PloS one*, *10*(8), e0134642.

MacLeod, C., Rutherford, E., Campbell, L., Ebsworthy, C., & Holker, L. (2002). Selective attention and emotional vulnerability: assessing the causal basis of their association through the experimental manipulation of attentional bias. *Journal of Abnormal Psychology*, *111*, 107–123.

Miller, W. R. (1998). Why do people change addictive behavior? *Addiction*, *93*, 163–172.

Moors, A., & De Houwer, J. (2006). Automaticity: a theoretical and conceptual analysis. *Psychological Bulletin*, *132*(2), 297–326.

Myrseth, K. O. R., & Fishbach, A. (2009). Self-control a function of knowing when and how to exercise restraint. *Current Directions in Psychological Science*, *18*(4), 247–252.

Neumann, R., & Strack, F. (2000). Approach and avoidance: the influence of proprioceptive and exteroceptive cues on encoding of affective information. *Journal of Personality and Social Psychology*, *79*, 39–48.

Noë l, 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.

Norman, D. A., & Shallice, T. (1986). Attention to action: Willed and automatic control of behavior. In R. J. Davidson & G. E. Schwartz & D. Shapiro (Eds.), *Consciousness and self regulation: Advances in research*, Vol. IV (Vol. IV). New York: Plenum Press.

Ostafin, B. D., Marlatt, G. A., & Greenwald, A. G. (2008). Drinking without thinking: An implicit measure of alcohol motivation predicts failure to control alcohol use. *Behaviour Research and Therapy*, *46*(11), 1210–1219.

Ostafin, B. D. & Palfai, T. P. (2006). Compelled to consume: The Implicit Association Test and automatic alcohol motivation. *Psychology of Addictive Behaviors*, *20*, 322–327.

Peeters, M., Monshouwer, K., van de Schoot, R. A., Janssen, T., Vollebergh, W. A., & Wiers, R. W. (2013). Automatic processes and the drinking behavior in early adolescence: a prospective study. *Alcoholism: Clinical and Experimental Research*, *37*(10), 1737–1744.

Pessoa, L. (2009). How do emotion and motivation direct executive control? Trends in Cognitive Sciences, 13(4), 160–166.

1st PROOFS – NOT FOR DISTRIBUTION

6870P REFLECTIVE BEHAVIOUR-A/lb_New supps Royal Combo ligs US 6 x 9 01/06/2016 17:25 Page 186

Pieters, S., Burk, W. J., Van der Vorst, H., Engels, R. C., & Wiers, R. W. (2014). Impulsive and reflective processes related to alcohol use in young adolescents. *Frontiers in Psychiatry*, *5*, 56.

Rooke, S. E., Hine, D. W., & Thorsteinsson, E. B. (2008). Implicit cognition and substance use: A meta-analysis. *Addictive Behaviors*, *33*, 1314–1328.

Schoenmakers, T., Lux, I., Goertz, A., Van Kerkhof, D., De Bruin, M. & Wiers, R. W. (2010). A randomized clinical trial to measure effects of an intervention to modify attentional bias in alcohol dependent patients. *Drug and Alcohol Dependence*, *109*, 30–36.

Schoenmakers, T., Wiers, R. W., Jones, B. T., Bruce, G. & Jansen, A. T. M. (2007). Attentional retraining decreases attentional bias in heavy drinkers without generalization. *Addiction*, *102*, 399–405.

Schneider, W., & Chein, J. M. (2003). Controlled & automatic processing: behavior, theory, and biological mechanisms. *Cognitive Science*, *27*(3), 525–559. http://doi.org/10.1207/s15516709cog2703_8

Seger, C. A. (2008). How do the basal ganglia contribute to categorization? Their roles in generalization, response selection, and learning via feedback. *Neuroscience and Biobehavioral Reviews*, *32*(2), 265–78.

Sharbanee, J. M., Stritzke, W. G., Wiers, R. W., Young, P., Rinck, M., & Macleod, C. (2013). The Interaction of Approach-Alcohol Action Tendencies, WM Capacity, and Current Task Goals Predicts the Inability to Regulate Drinking Behavior. *Psychology of Addictive Behaviors*, *27*(3), 649–661.

Smith, E. R. & DeCoster, J. (2000). Dual process models in social and cognitive psychology: conceptual integration and links to underlying memory systems. *Personality and Social Psychology Review*, *4*, 108–131.

Stacy, A. W. (1997). Memory activation and expectancy as prospective predictors of alcohol and marihuana use. *Journal of Abnormal Psychology*, *106*, 61–73.

Stacy, A. W., Ames, S. L., & Knowlton, B. (2004). Neurologically plausible distinctions in cognition and habit relevant to drug abuse prevention. *Substance Use and Misuse*, *39*, 1571–1623.

Strack, F. & Deutsch, R. (2004). Reflective and impulsive determinants of social behavior. *Personality and Social Psychology Review*, *3*, 220–247.

Strack, F., Martin, L. L., & Stepper, S. (1988). Inhibiting and facilitating conditions of the human smile: A nonobtrusive test of the facial feedback hypothesis. *Journal of Personality and Social Psychology*, *54*(5), 768–777.

Stroebe, W., van Koningsbruggen, G. M., Papies, E. K., & Aarts, H. (2013). Why most dieters fail but some succeed: a goal conflict model of eating behavior. *Psychological Review*, *120*(1), 110–138.

Tahaney, K. D., Kantner, C. W., & Palfai, T. P. (2014). Executive function and appetitive processes in the self-control of alcohol use: The moderational role of drinking restraint. *Drug and Alcohol Dependence*, *138*, 251–254.

Thush, C., Wiers, R.W., Ames, S. L., Grenard, J. L., Sussman, S., & Stacy, A.W. (2008). Interactions between implicit and explicit cognition and WM capacity in the prediction of alcohol use in at-risk adolescents. *Drug and Alcohol Dependence*, *94*, 116–124.

Townshend, J. M., & Duka, T. (2007). Avoidance of alcohol-related stimuli in alcohol-dependent inpatients. *Alcoholism: Clinical and Experimental Research*, *31(*8), 1349–57.

Van Deursen, D., Salemink, E., Boendermaker, W. J., Pronk, T., Hofmann, W., & Wiers, R. W. (2015). Executive functions and Motivation as Moderators of the Relationship between Automatic Associations and Alcohol Use in Problem Drinkers seeking Online Help. *Alcoholism: Clinical and Experimental Research*, *39*(9), 1788–1796.

1st PROOFS – NOT FOR DISTRIBUTION

6870P REFLECTIVE BEHAVIOUR-A/lb_New supps Royal Combo ligs US 6 x 9 01/06/2016 17:25 Page 187

van Deursen, D. S., Salemink, E., Smit, F., Kramer, J., & Wiers, R. W. (2013). Web-based cognitive bias modification for problem drinkers: protocol of a randomised controlled trial with a 2x2x2 factorial design. *BMC Public Health*, *13*, 674.

Van Hecke, J., Gladwin, T. E., Coremans, J., Destoop, M., Hulstijn, W., & Sabbe, B. (2010). Prefrontal, parietal and basal activation associated with the reordering of a two-element list held in WM. *Biological Psychology*, *85*(1), 143–148.

Vanderschuren, L. J., & Everitt, B. J. (2004). Drug seeking becomes compulsive after prolonged cocaine self-administration. *Science*, *305*(5686), 1017–1019.

Vink, M., Pas, P., Bijleveld, E., Custers, R., & Gladwin, T. E. (2013). Ventral striatum is related to within-subject learning performance. *Neuroscience*, *250*(10), 408–416.

Vogt, J., De Houwer, J., Crombez, G. & Van Damme, S. (2013). Competing for Attentional Priority: Temporary Goals Versus Threats. *Emotion*, *13*(3), 587–598.

Volkow, N. D., & Baler, R. D. (2015). NOW vs LATER brain circuits: implications for obesity and addiction. *Trends in Neurosciences*, *38*(6), 345–352.

Volkow, N. D., Fowler, J. S., & Wang, G.-J. (2004). The addicted human brain viewed in the light of imaging studies: brain circuits and treatment strategies. *Neuropharmacology*, *47*, Suppl 1, 3–13.

Wiers, C. E., Stelzel, C., Gladwin, T. E., Park, S. Q., Pawelczack, S., Gawron, C. K., . . . Bermpohl, F. (2015). Effects of Cognitive Bias Modification Training on Neural Alcohol Cue Reactivity in Alcohol Dependence. *American Journal of Psychiatry*, *172*(4), 335–343.

Wiers, R. W., Boelema, S. R., Nikolaou, K. & Gladwin, T.E. (2015). On the Development of Implicit and Control Processes in Relation to Substance Use in Adolescence. *Current Addiction Reports*, *2*, 141–155.

Wiers, R. W., Houben, K., Fadardi, J. S., van Beek, P., Rhemtulla, M. T., & Cox, W. M. (2015). Alcohol Cognitive Bias Modification Training for Problem Drinkers over the Web. *Addictive Behaviors*, *40*, 21–26.

Wiers, R. W., Bartholow, B. D., van den Wildenberg, E., Thush, C., Engels, R.C.M.E., Sher, K. J., Grenard, J., Ames, S. L., & Stacy, A. W. (2007). Automatic and controlled processes and the development of addictive behaviors in adolescents: A review and a model. *Pharmacology, Biochemistry and Behavior*, *86*, 263–283.

Wiers, R. W., Beckers, L., Houben, K., Hofmann, W. (2009a). A Short Fuse After Alcohol: Implicit Power Associations Predict Aggressiveness after Alcohol Consumption in Young Heavy Drinkers with Limited Executive Control. *Pharmacology, Biochemistry and Behavior*, *93*, 300–305.

Wiers, R. W., Eberl, C., Rinck, M., Becker, E. & Lindenmeyer, J. (2011). Re-training automatic action tendencies changes alcoholic patients' approach bias for alcohol and improves treatment outcome. *Psychological Science*, *22*(4), 490–497.

Wiers, R. W., Gladwin, T. E., Hofmann, W., Salemink, E., & Ridderinkhof, K. R. (2013). Cognitive Bias Modification and Cognitive Control Training in Addiction and Related Psychopathology: Mechanisms, Clinical Perspectives, and Ways Forward. *Clinical Psychological Science*, *1*(2), 192–212.

Wiers, R. W. Rinck, M., Dictus, M. & Van den Wildenberg, E. (2009b). Relatively Strong Automatic Appetitive Action-Tendencies in Male Carriers of the OPRM1 G-Allele. *Genes Brain & Behavior*, *8*, 101–106.

Wiers, R. W., Rinck, M. Kordts, R., Houben, K., & Strack, F. (2010). Re-training Automatic Action-Tendencies to Approach Alcohol in Hazardous Drinkers. *Addiction*, *105*, 279–287.

1st PROOFS – NOT FOR DISTRIBUTION

6870P REFLECTIVE BEHAVIOUR-A/lb_New supps Royal Combo ligs US 6 x 9 01/06/2016 17:25 Page 188

Wiers, R. W. & Stacy, A. W. (2006). Implicit cognition and addiction. *Current Directions in Psychological Science*, *15*, 292–296.

Wiers R.W., van Woerden, N., Smulders, F. T. Y. & De Jong, P. J. (2002). Implicit and Explicit Alcohol-Related Cognitions in Heavy and Light Drinkers. *Journal of Abnormal Psychology*, *111*, 648–658.

1st PROOFS – NOT FOR DISTRIBUTION