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Research report

Reward sensitivity predicts ice cream-related attentional bias assessed by inattentional blindness ☆

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ABSTRACT

The cognitive mechanism underlying the association between individual differences in reward sensitivity and food craving is unknown. The present study explored the mechanism by examining the role of reward sensitivity in attentional bias toward ice cream cues. Forty-nine college students who displayed high level of ice cream craving (HICs) and 46 who displayed low level of ice cream craving (LICs) performed an inattentional blindness (IB) task which was used to assess attentional bias for ice cream. In addition, reward sensitivity and coping style were assessed by the Behavior Inhibition System/Behavior Activation System Scales and Simplified Coping Style Questionnaire. Results showed significant higher identification rate of the critical stimulus in the HICs than LICs, suggesting greater attentional bias for ice cream in the HICs. It was indicated that attentional bias for food cues persisted even under inattentional condition. Furthermore, a significant correlation was found between the attentional bias and reward sensitivity after controlling for coping style, and reward sensitivity predicted attentional bias for food cues. The mediation analyses showed that attentional bias mediated the relationship between reward sensitivity and food craving. Those findings suggest that the association between individual differences in reward sensitivity and food craving may be attributed to attentional bias for food-related cues.

Introduction

Food craving refers to an intense desire to consume a certain food or food type that is difficult to resist (Chao, Grilo, White, & Sinha, 2014; Weingarten & Elston, 1991). Although food craving is a common phenomenon that most people have experienced at some point in life (Lafay et al., 2001), there are individual differences in it. For example, obese individuals were suggested to have higher food craving than normal weight individuals (Franken & Muris, 2005; White, Whisenhunt, Williamson, Greenway, & Netemeyer, 2002), and individuals with eating disturbances reported higher level of food craving compared to normal eaters (Greeno, Wing, & Shiffan, 2000; Ng & Davis, 2013; Van den Eynde et al., 2012).

Individual differences in food craving can be explained by the reinforcement sensitivity theory (Gray, 1987) with consideration of two systems: a behavioral activation system (BAS) responsive to reward cues, controlling appetite approach motivation, and a behavioral inhibition system (BIS) responsive to punishment (Gray, 1993). Individuals with high BAS are highly sensitive to reward and thereby more likely to detect the reward signals. Food craving and eating behavior are mainly motivated by the rewarding value of food (Berridge, 2004; Rolls, 1997). Certain foods, particularly those with a sweet taste, seem to be linked to pleasure and 'liking' reaction (Berridge, 2009), which can be regarded as reward cues predicting rewarding experience of eating food. Individuals with high BAS are therefore likely to translate pleasure into motivation of pursuing food reward, influencing food craving and eating behavior. Reward sensitivity, a stable 'psychobiological' personality trait (Davis et al., 2007), is expected to be related to food craving (Davis et al.,

Abbreviations: HICs, participants with high level of ice cream craving; LICs, participants with low level of ice cream craving; VAS, Visual Analog Scale; BIS, Behavior Inhibition System; BAS, Behavior Activation System; SCSQ, Simplified Coping Style Questionnaire; BDI, Beck Depression Inventory; SAS, Self-Rating Anxiety Scale.

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2007; Franken & Muris, 2005; Yen et al., 2010). For example, Yen et al. (2010) found that higher reward sensitivity is associated with craving response to high-sweet-fat foods in premenstrual dysphoric disorder.

However, the cognitive mechanism underlying the association between individual differences in reward sensitivity and food craving remains to be clarified. According to one possible explanation, the association is attributed to attentional bias to food cues. Attentional bias refers to the tendency to selectively attend to personally relevant information over neutral information (Mathews & MacLeod, 2005). It is speculated that individuals with higher reward sensitivity would have greater attentional bias toward food cues and higher food craving, compared to those with lower reward sensitivity. A recent study reported effects of reward sensitivity on attentional bias for alcohol cues among binge drinkers (White, Cunningham, Pearce, & Newnam, 2014). Attentional bias for food cues can be assessed by the Emotional Stroop paradigm (Dobson & Dozois, 2004; Johansson, Ghaderi, & Andersson, 2004; Roefs et al., 2005). It is assumed that appropriate emotional stimuli will be preferentially attended to by individuals for whom these stimuli are of primary concern. Employed with this paradigm, some studies found the correlation between attentional bias for food and craving (Braet & Crombez, 2003; Castellanos et al., 2009; Nijs, Muris, Euser, & Franken, 2010), whereas others reported null findings (Phelan et al., 2011; Soetens & Braet, 2007). The Stroop interference effect is a complicated cognitive process, which may involve attention, cognitive avoidance, and other non-attentional processes such as response bias (Jansen, Nederkoom, & Mulkens, 2005; MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002). Another paradigm commonly used was a modified dot-probe paradigm (Loeber et al., 2012; Smeets, Roefs, van Furth, & Jansen, 2008; Veenstra & de Jong, 2012). In this task, a word pair is displayed with one above the other, followed by a visual probe shown in the same position as one of the words. Subjects are asked to detect the probe as quickly as possible by indicating its location (MacLeod, Mathews, & Tata, 1986). Attention directed toward versus away from the particular emotional salient words can be differentiated by faster or slower probe detection, respectively. Similarly, mixed results regarding the correlation of attentional bias and craving were reported (Ahern, Field, Yokum, Bohon, & Stice, 2010; Boon, Vogelzang, & Jansen, 2000; Shafran, Lee, Cooper, Palmer, & Fairburn, 2007, 2008; Werthmann et al., 2011). The above null findings might be attributed to the approach–avoidance conflict reflecting attraction toward food and avoidance of food craving, which was more obvious in obese individuals (Werthmann et al., 2011), restrained eaters (Forestell, Lau, Gyurovski, Dickter, & Haque, 2012; Meule, Vögele, & Kübler, 2012) and individuals with eating disorder (Giel et al., 2011; Shafran et al., 2007, 2008). We speculated another possibility for the divergent results, that is, attentional bias studies are confounded by differences of coping style among the participant population. Coping is a set of behavioral and physiological responses in an attempt to solve problems and master internal conflict (Snyder, 1999; Zeidner & Endler, 1996). Coping style may be an important factor influencing craving and attentional bias. It is suggested that most people increase their food intake during stress (Epel et al., 2004; Stone & Brownell, 1994) and in return, feeling of stress could potentially trigger craving. Rather than rely on food intake, individuals with active coping style have more resources for dealing with stress and are less likely to develop attentional bias for food stimuli, compared with individuals with negative coping style. The important role of coping style has been evidenced in tobacco users (Kinnunen, Doherty, Militello, & Garvey, 1996; Vickers, Pattern, & Lane, 2003), alcohol users (Veenstra et al., 2007), and addicted internet users (Hetzel-Riggin & Pritchard, 2011; Kandell, 1998). Therefore, it is necessary to control confounding effect of coping style on craving and attentional bias.

The current study aims at investigating and clarifying the relationship between reward sensitivity, attentional bias, and craving. We used an advanced paradigm of the inattentional blindness (IB) task (Mack & Rock, 1998). According to IB, a supra-threshold but unexpected stimulus (200 ms duration) is not likely to be detected when subjects are attending to some other objects. A static IB task was developed in which subjects were first presented with several shape discrimination trials, and an extra stimulus was presented on the fourth trial without expectation. Then the subjects were asked whether they saw anything new. A large sample of subjects was tested and 75% of them failed to detect the extra stimulus (Mack & Rock, 1998). Interestingly, they found that certain stimuli with meaningfulness (e.g., a smiling face icon) were more easily noticed even under inattentional condition. The IB paradigm presents the unexpected but meaningful stimuli under the inattentional condition, which reduces strategic or effortful responses of participants. Those are often regarded as confounding cognitive processes for assessing attentional bias in other paradigms, such as the Emotional Stroop paradigm (Jansen et al., 2005) and the dot-probe paradigm (Lee & Telch, 2008). Therefore, the IB paradigm seems to provide a more direct measure of attentional bias to the rewarding cue itself. The utility of the IB paradigm for assessing attentional bias has been confirmed in the participants with social anxiety (Lee & Telch, 2008). One of the current aims is to examine the utility of the IB paradigm in evaluating attentional bias for food cues.

To our knowledge, this is the first study to investigate the relationship between reward sensitivity and attentional bias for food cues using the IB paradigm. Ice cream was selected as the target food with female adults being target participants, since ice cream was identified as one of the most frequently craved food among female cravers (Christensen & Pettijohn, 2001). It is hypothesized that participants with higher versus lower craving for ice cream would show greater attentional bias for ice cream, and participants with higher versus lower reward sensitivity would show greater attentional bias. Further, the relationship between reward sensitivity and food craving would be mediated by attentional bias. The sensitivity of reward was measured with the Behavior Inhibition System/Behavior Activation System (BIS/BAS) Scale (Carver & White, 1994), which was developed to assess Gray's BAS construct. Coping style was assessed by the Simplified Coping Style Questionnaire (SCSQ; Wang, Wang, & Ma, 1999) to control its potential influence.

Method

Participants

Participants were female undergraduate students from the Anhui Medical University and they were recruited by advertisement on campus. The study was approved by the Human Ethics Committee of the Anhui Medical University. All participants gave their consent by signing on the consent form and they were given gifts to thank them for their participation in the study.

Procedure

There were two sessions: a screening session and a testing session. The initial screening used the 10 cm Visual Analog Scale (VAS) for ice cream craving. Inclusion criteria were either a high (≥8) or low (≤2) score on the VAS. Participants with a high VAS score for ice cream were classified as high level of ice cream craving (HICs) and participants with a low VAS score for ice cream were classified as low level of ice cream craving (LICs). Among 341 individuals who were screened, 102 were recruited. Participants were also screened to ensure they did not have any clinical diseases. The Chinese versions of Beck Depression Inventory (BDI; Zheng, Wei,

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