Hedonism and health behaviour:
The influence of sensitivity to reward and punishment on substance use and food related behaviour.

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2008
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Abstract

Neuropsychological evidence demonstrates that a greater reward sensitivity might cause people to show more approach behaviour toward rewarding stimuli, more specifically food, alcohol, and drugs. Two systems might influence our approach behaviour toward rewarding stimuli: the brain reward system and the behavioural approach system (BAS). Another system is might to inhibit approach behaviours toward substance use, the Behavioural Inhibition System (BIS).

The relationship between these three systems and the approach behaviour toward the mentioned stimuli is researched in this article. Based on the evidence reviewed in this article, it can only be concluded that reward sensitivity causes approach behaviour toward food related stimuli. It cannot be concluded that there is a relationship between a sensitivity to reward and substance use. Furthermore, no evidence has been found in support of a relationship between a reactive BIS and substance use.

Keywords: Reward sensitivity, eating behaviour, substance use, BAS, BIS
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1: Introduction.

A lot of scientific research converges on the same conclusion that behaviour influences health. For instance, research done by Stefansdottir and Vilhjámsson (2007) shows that lifestyle is the major factor in causing diseases in the western world. But why do some people live an unhealthy lifestyle, for instance by overeating, or using drugs, and others do not? I will argue that this might be related to hedonism, and behavioural inhibition.

According to Crisp (2006), psychological hedonism is: “The view that human action -perhaps rational and deliberate human action- is motivated by a concern for the greatest expected balance of pleasure over pain.” (Crisp, 2006, p. 2). Later in this article, it will become clear that humans are motivated to pursue rewarding stimuli, including drugs, alcohol and food, because they induce a pleasurable feeling. The motivation to pursue these rewarding stimuli can therefore be considered hedonistic. In this article, it is hypothesized that people differ in their sensitivity to reward, and therefore differ in their motivation to pursue these rewarding, hedonistic, but often unhealthy, stimuli. Put differently, some people are more motivated to overeat, eat unhealthier food types, drink alcohol, or use drugs than others, because they are more sensitive to reward.

The relationship between sensitivity to reward and health compromising behaviour, more specifically, drug usage, alcohol usage, and eating behaviour, is the first of two relationships that are evaluated in this article. The second relationship that is evaluated here is the relationship between an inhibitory system, and alcohol and drug use.

To understand the relationship between rewarding stimuli and health compromising behaviour, it is important to have some insight into the brain reward system, and the Reinforcement Sensitivity Theory (RST) proposed by Gray (1987). Moreover, the first hypothesis is based on the evidence about the brain reward system, and the RST, because both provide an explanation for why humans are motivated to pursue rewarding stimuli: According to Kelley, Schiltz and Landry (2005) the brain reward system is the underlying neurobiological system for humans motivational
responses toward reward related cues. I therefore start with a brief overview of this system, followed by a brief introduction of Gray's (1987) reinforcement sensitivity theory, which provides a more personality oriented viewpoint on our responses toward rewarding stimuli in the form of the Behavioural Approach System. Furthermore, this theory also emphasizes the importance of second system, the BIS, or Behavioural Inhibitory System, which is considered to be responsible for anxiety based avoidance behaviour, and resolving goal conflicts. This leads to the second hypothesis in this article stating that the BIS is responsible for avoiding rewarding, but potentially health threatening, stimuli, more specifically alcohol and other drugs. A reactive BIS might therefore be another reason for why some people are less inclined to drink alcohol, or use drugs.

1.1: The Brain reward system.

There is evidence that pleasure is linked with the reward system in the human brain (Stefano et al., 2007). When this system is activated, for instance by eating, people get a pleasurable feeling, especially when it is activated by fat or sweet food, (Cota, Tschöp, Horvath & Levine, 2005). The reward system is a system which motivates a human being to go and find food and water to survive (Stefano et al., 2007). According to Fallon, Shearman, Sershen and Lajtha (2007) the brain reward system is not only activated by the stimulus of food itself, but also by other aspects of food, like smell, taste, and anticipation on food. These findings suggest that the brain reward system is important for the survival of the human species, because it motivates people to pursue stimuli necessary for survival. At least it was. Nowadays, the brain reward system might be less useful in the modern western society, where food is abundant. For instance, Zheng and Berthoud (2007) suggest that our brain reward system is equipped to defend us from starvation, but not from overeating. They also suggest that there are individual differences in the brain's ability to suppress overeating.

There is another hedonistic stimulus our brain reward system is not equipped to defend us
against: drugs (Stefano, et al. 2007). According to Stefano et al. (2007) drugs are capable of stimulating our brain reward system directly, inducing instant pleasure. Because drugs activate the brain reward system, inducing pleasure, people are motivated to use drugs, Stefano et al. (2007). Another difference, according to Stefano et al. (2007) between drugs and food is that the reactions of our brain system on drugs, are more potent, and cannot be controlled by aversive mechanisms. A nice explanation of how drugs, such as cocaine, influence the reward system is given by Kolb and Wishaw, (2003): Cocaine diminishes the reuptake of dopamine, which increases the amount of dopamine in the synaptic clefts, which in turn stimulates the neurotransmission in the reward system. A logical outcome is that the reward system becomes more active, inducing a pleasurable feeling directly. Different drugs influence the reward system in different ways, but all of the addicting drugs activate the reward system and thus induce a pleasurable feeling, (Kolb and Wishaw, 2003).

1.2: Reward and personality.

More evidence in support of reward sensitivity of people is found in the neurobiologically oriented personality theory proposed by Gray (1987) called the Reward Sensitivity Theory (RST). According to Gray (1987) three neuropsychological systems within the brain's circuits are responsible for emotional behaviour: (1) The fight or flight system, (2) the behavioural inhibition system (BIS), and (3) the behavioural approach system (BAS). People can differ in sensitivity of all three systems, meaning that there are individual differences. The last two systems, the BAS, and the BIS are most important in the context of this article. According to Gray, (1987) the BAS is responsible for organizing behaviour in response to positive, non punishment, and/or rewarding stimuli, like food and drugs. Or, put differently by Loxton and Dawe (2006), the BAS can be considered sensitivity to reward at the personality level. The BIS is responsible for anxiety based avoidance behaviour, (Gray 1987), and: “Those with a more reactive BIS are more likely to inhibit
approach behavior that is accompanied by subjective feelings of anxiety/frustration” (Gray in Dawe, Gullo and Loxton 2004, p. 1341). In the revision of the RST, McNaughton and Gray (2000) assert that the BIS is responsible for resolving goal conflict, by inhibiting prepotent conflicting behaviour, assessing risk and scanning memory. An example of a goal conflict in the context of this article, is when a person wants experience pleasure by using drugs, but fears addiction.

To measure both BIS and BAS Carver and White (1994) have developed a BIS/BAS questionnaire. This questionnaire distincts between three subscales when considering the BAS: The BAS reward scale, (e.g. “When I get something I want, I feel excited and energized”) the BAS drive scale, (e.g. “When I want something, I usually go all out to get it”) and the BAS fun seeking scale (e.g. “I will often do things for no other reason than that they might be fun”).

1.3 Research questions.

I hypothesize that a greater sensitivity to reward causes a greater motivation to pursue rewarding stimuli. This is what leads to the first major guiding question in this overview: What is the relationship between sensitivity to reward, and the motivation to use drugs, drink alcohol and/or overeat? Secondly, I hypothesize that greater BIS reactivity causes a greater motivation to inhibit the pursuit for rewarding stimuli. This is what the second major guiding question addresses: What is the relationship between a more reactive inhibitory system (BIS) and the motivation to avoid drugs and alcohol?

2. Method

To find the articles used in for this article the following search databases were used: Google scholar, Pubmed, PsycInfo, and the library database of Tilburg University. Furthermore, the following search terms were used: Hedonism, reward, system, behavior, behavioral, activation, inhibition, BAS, and BIS. More articles were found in the references of articles that were already
reviewed. The articles were selected based on relevance for the discussed topics, i.e., hedonism, the brain reward system, the response sensitivity theory, BAS, BIS, substance use, food related behaviour, and addiction.

The relationship between hedonism and health behaviour was the starting point of this article. Hedonism is not something that can be measured directly, because it is a philosophical idea. Therefore, sensitivity to reward was used as an indication of an individual's hedonism. Reward sensitivity was compared to eating behaviour and substance use, to research the relationship between reward sensitivity and health behaviour. When reviewing the articles, another system, the BIS, was suggested to influence the relationship between reward sensitivity and eating behaviour and substance use. No articles about the relationship between the BIS and eating behaviour were found, therefore only the relationship between the BIS and substance use was researched.

3.1 Sensitivity to reward and eating behaviour.

One of the first researchers who suggested that the capacity of experiencing pleasure was normally distributed in the population, was Mheel (1975), with hedonia, i.e, enhanced motivation to pursue pleasurable stimuli, and enjoying them, on one side of the distribution, and anhedonia on the other, meaning the opposite. This normal distribution implies individual differences in sensitivity to reward. Further research has demonstrated that these differences are neurobiologically explained by individual differences in sensitivity to reward. A link between a greater reward drive, measured by the BIS/BAS scales, and tasty pictures of food is laid by Beaver, Lawrence, van Dizhuijzen, Davis, Woods and Calder (2006). They have done this by comparing scores on the Behavioural Activation Scale with the activation of the brain reward system when seeing pictures of tasty food. Indeed, people who score higher on the BAS drive scale showed more activation of the brain reward system when exposed to pictures of tasty food, and they are at higher risk of becoming obese. This finding confirms that people with a greater motivation to pursue reward do have a more sensitive brain
reward system, and even more importantly, that these people who are more sensitive to reward, are at greater risk of becoming obese. This result is supported by van den Bos, (2006), who emphasizes that there also are individual differences in cognitive self control, which counteracts on the brain reward system.

Davis, Stachan and Berkson (2004) found a positive relationship between sensitivity to reward, conceptualized as a low score on a physical anhedonia scale, and emotional overeating in adult women. Loxton and Dawe (2000) find that young girls who show dysfunctional eating behaviour, reflecting the drive for thinness, but also bulimia, show a significantly higher score on the BAS-drive scale compared to a control group. Research done by Loxton and Dawe (2006) shows a positive relationship between reward sensitivity and dysfunctional eating behaviour, in the form of drive for thinness and bulimia. Franken and Muris, (2005) found that there is a significant positive correlation between reward sensitivity, as measured by the Sensitivity to Punishment Sensitivity to Reward Questionnaire (SPSRQ; Torrubia, Avila, Molto, and Caseras, 2001), and food craving. Research done by Davis et al. (2007) provides convincing evidence in support of the first hypothesis: This research converges to a model which shows a causal relationship between sensitivity to reward, associated with both a score on the sensitivity to reward scale, and a sensitive BAS. Furthermore a significant association was found between reward sensitivity and overeating (Davis et al. 2007). In addition, the model shows a causal relationship between reward sensitivity and food preferences, which in turn is related with high fat food and sugar rich food.

In conclusion, the research reviewed in this section provides evidence for a positive causal relationship between reward sensitivity and, overeating, preferences for high fat and sugar rich food types. Furthermore, evidence for a relationship between reward sensitivity and, bulimia, drive for thinness, and food craving has been shown in the reviewed research.
3.2 Reward sensitivity and substance use.

According to van den Bos (2006), individual differences in motivation to pursue reward are the same for multiple potentially rewarding stimuli: “What obesity is for one person, is alcoholism for another”. Therefore the same positive relationship as reward sensitivity and substance use can be expected between reward sensitivity and eating behaviour.

Research done by Zisserson and Palfai (2007), among hazardous drinkers, shows that there is a positive relationship between BAS sensitivity, measured by the BIS/BAS questionnaire, and the urge to drink alcohol, the arousal, and pleasure (at the moment of the research) before an alcohol related cue was given to the subjects. Zisserson and Palfai (2007) found somewhat stronger relationships between the same variables after an alcohol related cue was given to the participants of the study. Franken (2002), who also used the BIS/BAS questionnaire, demonstrated that there are positive relationships between BAS-drive and desires and intentions to drink alcohol, and negative reinforcement aspects of drinking when exposed to alcohol related cues, in a sample of alcoholics in treatment. In the same study, Franken (2002) also demonstrated a positive relationship between BAS-reward sensitivity and negative reinforcement aspects of drinking when exposed to alcohol related cues. Franken (2002) drew the following conclusions: “Subjects with high BAS-drive scores experienced significantly more strong desires, intentions to drink alcohol, and negative reinforcement craving during exposure to alcohol related cues than subjects with low BAS-drive scores. Furthermore, people with high BAS-reward responsiveness experienced high negative reinforcement craving during this exposure.” (Franken, 2002, p. 5). Similar results were found among young women by Loxton and Dawe (2000). Young women who misuse alcohol scored significantly higher on both the BAS-drive and the BAS-fun seeking scale of the BIS/BAS questionnaire, compared to a control group. According to these authors there is also a positive association between reward sensitivity, measured by the SPSRQ, and hazardous drinking, in university women.
Kneyazev, Slobodskaya, Kharchenko and Wilson (2004) found that sensitivity of the BAS, measured by the Gray Wilson Personality Questionnaire (GWPQ-S), predicts substance use in Russian adolescents, when controlled for peer pressure. They found a positive correlation between BAS and substance use, with BAS explaining 10.5% of the substance use variance. Franken, Muris and Georgieva, (2006) reported significant between group differences between non-addicts and drug addicts on the BAS-drive scale, BAS fun seeking scale, and the BAS total score, but not the BAS reward scale. They conclude that drug addicts are not more sensitive for reward generally, but have a heightened sensitivity to cues associated with reward. Johnson, Turner and Iwata (2002) found only a significant relationship between lifetime drug dependence and BAS compared to nondrug users. Simons and Arens (2007), found no significant relationship between marijuana use and a reward sensitivity, measured by the SPSRQ, in university students.

To summarize, some research demonstrates a positive relationship between reward sensitivity and substance use, most research does not confirm this relationship. The research does provide evidence relationship between the BAS in general, BAS-drive, and BAS-fun seeking and substance use.

3.3: The BIS and unhealthy behaviour.

Evidence that there is a system which inhibits our response to potentially rewarding is found in the study of Sinha and Ray Li (2008) According to these authors there is a relationship between impairment in inhibitory control and substance abuse, addiction and relapse. The same cannot be concluded about the relationship between a reactive BIS and substance abuse. Although Kimbrel, Nelson-Gray and Mitchell (2006) found a weak relationship between a more reactive BIS and alcohol abuse, several other studies, (Franken and Muris (2006); Franken et al., (2006); Johnson, Turner and Iwata, (2003); Zisserson and Palfai (2007)) find no relationship between a reactive BIS and alcohol abuse. These results are further supported by a study by Nijs, Franken, Fren and
Smulders (2007), who found no association between people’s BIS scores and p300 amplitude. Low p300 amplitudes are associated with vulnerability to developing substance abuse disorders. When considering substance use in general research done by Knyazev et al. (2004) demonstrated a slight positive relationship between BIS and substance abuse for adolescent boys and a slight negative relationship for girls. The researchers conclude that young women, but not young men, with high BIS reactivity are slightly more inclined to avoid using drugs.

To summarize, most research does not show a relationship between a reactive BIS and substance use.

4.1 Discussion and Conclusions.

Based on these results it can be concluded that there is a positive causal relationship between sensitivity to reward and the motivation to overeat and the preference for high fat and sugar rich food types: People who are more sensitive to reward, are more motivated to overeat, and eat fatter and more sugar rich food. A less expected result is that people with a higher sensitivity for reward also show an increased drive for thinness and bulimic behaviour.

Secondly, based on these results it cannot be concluded that there is a causal relationship between sensitivity to reward and substance use. Moreover, it cannot be safely concluded that there is any relationship at all between sensitivity to reward and substance use, because of the contradictions in the reviewed articles: some articles do find a positive relationship between sensitivity to reward and substance use, while others do not. It should be noted, that one of the articles (Loxton and Dawe, 2000) shows a positive relationship between hazardous drinking and reward sensitivity, while this is the only reviewed article that addresses this relationship while comparing non substance dependant subjects with differences in reward sensitivity. These contradicting results suggest that sensitivity to reward may play a less significant role in whether someone engages in substance use behaviour, compared to eating behaviour. This result is does not
confirm the neuropsychological evidence, which suggests that the brain reward system is responsible for our behaviour toward rewarding stimuli, regardless of the type of stimulus, and reacts even stronger on drugs. In other words, the hypothesis that people are more motivated to overeat, eat fatter and more sugar rich food types, drink alcohol and/or use drugs because they are more sensitive to reward is not confirmed.

Finally, based on these results, it cannot be concluded that there is a relationship between reactivity of the BIS and substance use. Some research shows a weak relationship, while most research shows no relationship at all. Therefore it can be concluded that the second hypothesis is disconfirmed, based on these results.

4.2 Reward and BMI

This overview provides evidence that people who are more sensitive to reward are more motivated to overeat, eat fatter and more sugar rich food. This finding is important for research on, and treatment of, obesity, because people who overeat are at risk to becoming obese, which may lead to diabetes, cancer and heart disease, although the relationship between sensitivity to reward and BMI is not a linear one. Confirmation of this hypothesis was found in the results of Davis, Stachan and Berkson, (2003); Davis and Fox (2008) concerning BMI using a sensitivity to reward and punishment questionnaire. They found that there is not a linear relationship between BMI and reward sensitivity, but rather an inverted u-form relationship: People who are slightly to moderately overweight appeared to have the most sensitive reward system, but wherein people with a very high BMI have a lower reward sensitivity. When considering the BAS the same relationship between BAS and BMI has been found. According to Davis and Fox (2008) sensitivity to reward, conceptualized as a sensitive BAS, is possibly associated with a higher BMI, but the relationship reverses when a persons BMI reaches more extreme levels.
4.3 Elaborating: Reward sensitivity and substance use.

I further report some evidence on a relationship between reward sensitivity and substance use. However that evidence is inconclusive, because other studies (e.g., Franken, Muris and Georgieva, (2006); Simons and Arens (2007); Zisserson and Palfai (2007)) failed to show this relationship. Therefore more research is needed on this topic. Especially research with different populations, because three of the four study's that that used substance misusers as subjects, found no relationship between BAS-reward sensitivity and substance use, while other research considering non-substance users did find a positive relationship between reward sensitivity and hazardous drinking in young women. This also provides some evidence for a different relationship between alcohol use and reward sensitivity, compared to this relationship with drug users.

The reason why reward sensitivity might not be increased in addicts is because prolonged drug use can alter the brain's structures. In fact, Koob and LeMoal (2008) state that prolonged drug use changes peoples brain system in a way that they become less sensitive to the positive hedonistic effect of drug use, but become more sensitive to the negative effects of withdrawal. This finding implies a decrease in sensitivity of the reward system, when using drugs. Therefore it might be interesting to examine reward sensitivity, especially BAS reward sensitivity, among non-addicted individuals. Such research might be important for the prevention of substance abuse and/or addiction, because of the major consequences of this behaviour on health: Living a healthy life is associated habits of smoking, eating, drinking alcohol, drug use, coping with stress, accident prone behaviour, physical inactivity and appearance, Stefansdottir and Viljamsson (2007).

Furthermore, when considering the relationship between reward sensitivity and substance use, it should be noted that the researchers in the different studies have used different questionnaires, which address sensitivity to reward in different ways, to investigate this relationship. This might also explain some of the seemingly discrepant findings.

Given the present research, I expect that sensitivity to reward plays a less significant role in
substance use, especially drug use than in eating behaviour, probably because environmental factors might play a greater role in substance use. This might be explained by the fact that drugs cannot be easily obtained, or are socially accepted, in every environment, while for most people in the western society it is very easy to obtain food, without any direct social consequences. In other words, in order to obtain drugs it is necessary to seek out new, possibly risky, situations. Only one study (Loxton and Dawe, 2000) provided evidence of a relationship between reward sensitivity and drinking behaviour considering non alcoholics. Therefore it can be cautiously hypothesized that the same applies for this relationship as for the relationship between food and reward sensitivity. This is supported by the result that not people with a more BAS-reward sensitivity, but people with a greater BAS-drive, and BAS-fun seeking score are more inclined to (mis)use substances. The latter systems are more responsible for seeking out rewarding behaviours. Research done by Sher, Bartholow, and Wood (2000) showed that substance misusers score higher on an impulsiveness scale, especially on the novelty seeking subscale, while Dawe, Gullo, and Loxton (2004) suggest that impulsiveness might be related to a high BAS score. These statements provide evidence for the hypothesis that it is not reward sensitivity, but novelty seeking is a better predictor of substance use.

4.4 Guidelines for further research.

To summarize, in the present article the relationship between reward sensitivity and eating behaviour, and substance use is reviewed. It is plausible that the sensitivity to reward not only affects these behaviours, but also other potentially rewarding behaviours, like shopping, playing video games, gambling, and so on. Based on the current findings, the following hypothesis about the relationship between the response behaviours and reward sensitivity can be formulated: The relationship between the non-chemical stimuli, e.g. shopping, and reward sensitivity is the same as the relationship between food and reward sensitivity. Still another stimulus that might be
influenced by a sensitive reward system is Smoking. How reward sensitivity relates to this behaviour is another topic that is interesting to research.

When considering the BIS it must be concluded that there is no relationship between this system and health compromising behaviour. Because there is evidence (Sinha and Ray Li, 2008) that there is some sort of inhibitory system, further research about the relationship between behavioural inhibition and health compromising behaviour should be conducted. However, only substance related stimuli have been considered when researching the relationship between the BIS and inhibiting approach behaviours. It might be interesting to research these relationships, especially because of the differences between the relationships between reward sensitivity and food behaviours, compared to the relationships between chemical stimuli and reward sensitivity.
4. References


