Monoamine Oxidase in Regulation of Biopsychological Factors:

Correlates of Time Perspective, Sensation-Seeking, and Boredom Proneness

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**Abstract**

Monoamine oxidase is an enzyme known to play a role in the regulation of neurotransmitter levels in the brain. The effects of large amounts of this enzyme are that dopamine and serotonin levels are reduced. This fluctuation in neurotransmitter levels has been linked to several different factors of interest to the psychological community, such as affect, time perspective, and boredom. For instance, as serotonin and dopamine levels decrease, affect also decreases. This change in affect has some short-term consequences on one’s time perspective. The neurological processes that cause changes in affect are also related to changes in cognition and boredom, which ultimately alter sensation-seeking tendencies.

*Keywords:* monoamine oxidase, sensation-seeking, time perspective, boredom, affect, serotonin, dopamine

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The purpose of this paper is to examine the correlates of time perspective, sensation-seeking, and boredom proneness. Specifically, it will look at the effects of the neurotransmitters dopamine and serotonin, as these seem to play a prominent role in the influence of behaviors, especially when it comes to time perspective and sensation-seeking. Because these neurotransmitters are so notable in the literature, and because there is a well-recognized difference in the level of these neurotransmitters between men and women, this review will briefly consider gender differences in each of the previously-mentioned areas of interest. For purposes of specificity, this review will discuss these topics in the context of the tendency to take part in impulsive, short-term, risk-taking behaviors (e.g., gambling, drunk driving, drug use, etc.), rather than in the context of a long-term, cognitive process. These topics and their relationships will then be related to the common factor of the enzyme monoamine oxidase. The effects of this enzyme in contributing to the correlation of time perspective, sensation-seeking, and boredom will be analyzed.

**Time Perspective**

When it comes to the notion of time, there are two main areas of psychological study: time perception – the way in which one perceives time as it passes; and time perspective – the timeframe one brings into focus when thinking about one’s life. This literature review emphasizes the latter, time perspective, as it tends to be perceived more consciously rather than subconsciously, yet it seems to play several subconscious roles in altering sensation-seeking, motivation, and boredom (Zakay, 2014; Zimbardo & Boyd, 1999).

Time perspective has been divided in the literature to define the different possible perspectives one can have. These include past-negative, past-positive, present-hedonistic, present-fatalistic, and future (Zimbardo & Boyd, 1999). A past-negative view would be one in which a person mostly concentrates on negative events in the past and does not think about the benefits of those events or how the circumstances they caused may be changed. Someone with a past-positive view, on the other hand, might be characterized as melancholy, always dreaming about “better times” and not entirely cognizant of the good things in the present and future. Present-hedonistic is the view that one should “live for the present.” Such view-holders try to enjoy the present as much as they can, believing that the past should not be worried about because it is gone and that the future should not be worried about because it cannot be changed. People who have present-fatalistic views have a similar feeling about the future, however they are not enjoying their present. They feel that there is no good coming from their current situation, and they feel defeated by the thought that they cannot change their future. Finally, someone with a future orientation does not often worry about the present or past. They tend to be somewhat focused on what they are doing in the present, but only to the extent of recognizing how it will allow them to reach their future goals, which are their main concern (Zimbardo & Boyd, 1999).

There have been many studies suggesting that time perspective can be an important factor affecting the way one perceives life circumstances and well-being (Strack, Schwarz, & Gschneidinger, 1985; Zimbardo & Boyd, 1999). Especially when combined with affect – positive or negative – it can determine the lens through which someone views their current life situations. For example, in one study by Strack, et al. (1985), participants were asked to think about either positive or negative events in the distant past. They were then asked to rate their overall life satisfaction, happiness, and their current mood. The results showed that thinking about negative and positive events had an influence on mood. When strong emotional affect was elicited by the event, the participant was more likely to report being more or less satisfied with their life, depending on if the affect was positive or negative, respectively (Strack, Schwarz, & Gschneidinger, 1985). Thus, if a person had a past-negative orientation and spends a lot of time thinking about negative events from their past, they may be more inclined to have low life satisfaction and think that their life is not meaningful.

A possible biological influence on affect and time perspective may be found in the activity of 5-hydroxytryptamine (5-HT) serotonin receptors. These receptors reside in the amygdala and hippocampal regions of the brain and have been found to have an effect on aggression, affect, and mood (Brunner, & Hen, 1997). Increased serotonin activity at these receptors would potentially alter the way in which one views their quality of life, thus affecting their perceived quality of life and changing their time perspective.

**Sensation-Seeking**

Sensation-seeking is defined as taking part in impulsive, and sometimes risky, behaviors that lead to an increase of dopaminergic activity (Daitzman & Zuckerman, 1980). To measure one’s tendencies to pursue such behaviors, there have been a few scales created by various researchers, the most prominent of which is Zuckerman’s Sensation-Seeking Scale (SSS; Zuckerman, et al., 1964). Zuckerman, et al. (1964) defines this scale, specifically, as an analyzation of one’s tendency to seek out risky situations or scenarios based on one’s “sensitivity to internal sensations” (p.480). This scale has been further researched and broken down into four subscales: Disinhibition, Thrill and Adventure Seeking, Experience Seeking, and Boredom Susceptibility (Zuckerman, et al., 1978). Disinhibition (Dis) is defined as the inability to refrain from risky, wild behaviors; Thrill and Adventure Seeking (TAS) is the tendency to engage in thrill-giving activities; Experience Seeking (ES) is the tendency to live a “non-conforming lifestyle” (pg. 140); and Boredom Susceptibility (BS) is a measure of how easily or readily one tires of an activity or task (Zuckerman, et al., 1978).

Zuckerman, et al. (1978) found that males tend to have higher scores on the SSS than females, and also that the scores for both genders decrease with age. He suggests that the cause for this is changes in gonadal hormone systems, which could potentially account for both observations. In fact, there have been studies to support the hypothesis that hormone differences can be responsible for differences in sensation-seeking. Daitzman and Zuckerman (1980) found that men tend to score higher on the Dis and TAS subscales in the Zuckerman’s SSS. They also found that levels of both androgen and estrogen hormones correlated with the age and sex differences on both subscales.

When looking at age differences alone, Steinberg, et al. (2008) hypothesized that the high sensation-seeking behavior often observed in adolescents is due to the natural development of the dopamine system. During adolescence, dopamine levels in the brain increase, then decrease, leading to more sensation-seeking behaviors as an attempt to compensate for the decrease of pleasurable sensations (Steinberg, et al., 2008). Furthermore, it has been found that testosterone levels correlate with sensation-seeking behaviors in both genders (Steinberg, et al., 2008). This is significant in relation to the hypothesized reason for adolescent increase in sensation-seeking because, not only is testosterone well-known to increase during adolescence, which has often been attributed to changes in behavior and mood (Duke, Balzer, & Steinbeck, 2014), but testosterone has also been identified as a dopamine inhibitor (Simpkins, Kalra, & Kalra, 1983), which makes sense in the context of Steinburg’s hypothesis (Steinberg, et al., 2008).

Feelings of strong positive and negative affect have been found to correlate, not only with serotonin levels, as discussed above, but also with dopamine levels (Ashby, Isen, & Turken, 1999). The levels of both neurotransmitters correlate most strongly with positive affect but have also been found in negative affect situations related to anxiety and stress. People who are more sensitive to dopamine typically have higher affect and tend to be more extraverted, meaning they tend to seek out new and exciting experiences (Ashby, et al., 1999). They have also have been found to have higher levels of sensation-seeking (Daitzman & Zuckerman, 1980). Why would people with already-high dopamine levels seek to raise those levels? The explanation is likely that, in having high dopamine levels, they have built up a sort of tolerance to its pleasurable effects (Ashby, et al., 1999). When they are involved in activities that others may find very rewarding, they are less affected by the releases of dopamine because they have so much of the neurotransmitter already circulating in their brain. Thus, to get a rewarding experience, they take part in activities that give them more of a mental rush, which usually take the form of increased sexual activity, gambling, drinking, drug usage, and/or aggressive driving. Often, these activities start off as being relatively mild and infrequent, but as the person learns to expect the pleasure and adapt to it, he or she will be more likely to increase frequency and riskiness of the behavior(s) (Ashby, et al., 1980).

**Boredom Proneness**

Boredom is thought to be the result of decreased cognitive activity (i.e., the less you engage in thinking about and/or doing something, the more likely it is that you will become bored; Watt & Blanchard, 1994). A scale commonly used to assess one’s tendency to become bored is the Boredom Proneness Scale (BPS). It has been found that scores on the Need for Cognition scale – which measures one’s enjoyment of and preference for cognitive activities – and BP scores are positively correlated (Watt & Blanchard, 1994; Zakay, 2014). Related to this notion, it is of interest to note that affect – or one’s emotional state – and boredom are also correlated with each other (Vodanovich & Kass, 1990), as are affect and cognition (Ashby, et al., 1999).

The factor tying these three correlations together is likely dopamine levels. Low levels of dopamine have been found to correlate with low cognitive flexibility, which is hypothesized to be a possible cause of cognitive decline in aging, as dopamine levels in the brain decrease at a rate correlated with age increase (Ashby, et al., 1999). While affect and cognitive flexibility are correlated, so are dopamine and affect; low affect, such as that seen with mild depressive symptoms, is linked to low dopamine levels (Ashby, et al., 1999). Thus, it is possible that, as dopamine levels become lower, affect is decreased, which reduces cognition, which then results in boredom.

Boredom proneness is also one of the hypothesized causes of impulsive sensation-seeking; in fact, one of the subscales in Zuckerman’s SSS is even termed “Boredom Susceptibility” (Zuckerman, et al., 1978). This makes logical sense: if a person is often bored with daily activities, he or she is more likely to try to find other ways to pass time and relieve that boredom (Vodanovich & Kass, 1990). Vodanovich (2003) found a high correlation between the BPS and Zuckerman’s SSS, indicating that the more tendency a person has of becoming bored, the higher that person’s tendency will be to take part in impulsive behaviors.

**Time Perception and Serotonin**

Although not a focus of this review, it is worthwhile to briefly mention time perception as it relates specifically to boredom. As mentioned above, time perception is the rate at which one perceives time passing. It has often been noted in the literature that boredom is correlated with slowed time perception (Vodanovich & Kass, 1990; Watt & Blanchard, 1994). The more bored a person is, the slower the person will perceive the passage of time (Brunner & Hen, 1997; Vodanovich & Kass, 1990; Watt & Blanchard, 1994). The quantity of 5-HT serotonin receptors, mentioned above, are thought to play a role in regulating time perception (Brunner & Hen, 1997). With more of these receptors present to take up serotonin – provided enough serotonin is available – affect will increase, but the amount of serotonin will then go down because of its absorption by the receptors. This reduction is correlated with slower time perception (Brunner & Hen, 1997). Therefore, it is possible that affect actually does not have a direct effect on cognition, but that the two are simply correlated due to related biological processes. This would mean that, while serotonin levels in 5-HT receptors alter affective states (and thus alter time perspective), the levels of serotonin not used in that process have a different neurological function that results in changes in cognition, boredom, and time perception.

**Monoamine Oxidase**

**What is Monoamine Oxidase?**

Monoamine Oxidase (MAO) is an enzyme that is used in the process of breaking down dopamine and serotonin, among many other neurotransmitters. Because of its high importance in regulating activity of neurotransmitters in the brain, it is a useful factor to consider when looking at the common link between related behaviors. The gene that codes for the production of MAO is found on the X-chromosome, which means that women naturally produce more of it than men (Shih, Chen, & Ridd, 1999; Robinson, et al., 1971). This is thought to be a reason for the increased levels of depression in women, as they would have less serotonin due to the activity of MAO (Daitzman & Zuckerman, 1997; Robinson, et al., 1971), and for the fact MAO inhibitors can be used as an effective treatment of depression (Robinson, et al., 1971). It is also hypothesized to be one of several causes for personality differences between men and women (Hunter, 2010). For these reasons, MAO is of interest in the context of the relationships between time perspective, sensation-seeking and boredom.

**MAO and Time Perspective**

The effects of MAO on time perspective are relatively straight-forward. Fluctuations in MAO levels would change the levels of dopamine and serotonin present in the brain (Daitzman & Zuckerman, 1980). The levels of these neurotransmitters would alter affect (Brunner & Hen, 1997), which could change the way a person views life situations, thus potentially changing their time perspective (Strack, Schwarz, & Gschneidinger, 1985). For example, lots of MAO would mean less dopamine and serotonin, lower affect, and negative perceived quality of life. Thus, in such a situation, a person would likely have either a past-negative or present-fatalistic time perspective. This flow of logic is supported by observations made in the literature. Zimbardo and Boyd (1999) found that both past-negative and present-fatalistic time perspectives were positively correlated with depression, suggesting low levels of serotonin which may likely be a result of higher levels of MAO.

**MAO and Sensation-Seeking**

According to Zimbardo and Boyd (1999), time-perspective is a precursor for specific behaviors, one of which would be sensation-seeking. He found that people who scored low on Zuckerman’s SSS were more likely to have a future-oriented time perspective when tested on Zimbardo’s Time Perspective Inventory (ZTPI). This is logical, as people who are highly concerned with the future would be less focused on the present, meaning that they would spend less time trying to entertain themselves.

This makes sense in the context of neurotransmitter levels as well. While, as mentioned above, adolescents have high sensation seeking due to a lowered amount of dopamine (Steinberg, et al., 2008), some people naturally have lower-than-average levels of dopamine throughout their life. If the levels of dopamine are always low, then the reward for doing pleasurable things may not be as strong. A person in such a situation may have less desire to pursue pleasurable sensations because they do not produce enough reward for the action to be worth the effort.

**MAO, Boredom, and Time Perception**

As MAO levels alter levels of dopamine and serotonin, changing affectual states, boredom levels also change, as does time perception. It is very likely that affect influences time perspective, but whether the serotonin levels or 5-HT receptors have a direct influence on cognition, boredom, and time perception is unknown. To explore the previously-mentioned possibilities, it may be that as serotonin increases at 5-HT receptors, affect also increases, which increases cognition and decreases boredom, thus speeding time perception. Or, it could be that, while affect and cognition are correlated, they have no direct causal relationship, instead being altered by the activity of the 5-HT receptors. In either case, it is clear that a relationship could exist between each of these factors, being influenced first by levels of MAO, and then resulting in either a speeding-up or slowing-down of time perception, which changes one’s sensation-seeking tendencies.

**Conclusions**

The regulation of neurotransmitter levels through MAO is of great consequence to time perspective, sensation-seeking, and boredom proneness. It regulates the actions of the neurotransmitters dopamine and serotonin, which seem to be the key factors that tie together the relationship between all these variables. The way serotonin and dopamine change affect seems to influence time perspective and boredom independently, but the results of boredom on sensation-seeking then seem to relate back to time perspective in a somewhat cyclic manner.

When considering the larger picture, it is clear that boredom proneness and sensation-seeking – and their intermediates of affect, cognition, and time perception – are closely related to each other. It is also evident that sensation-seeking tendencies and time perspectives are related to each other, but less directly, through many intermediate biological and psychological factors, which are beyond the scope of this review.

**Limitations and Future Directions**

This review made some important connections regarding the way various neurotransmitters, hormones, and enzymes in the brain interact with one another. It also speculated on what possible roles they could play in regulating behaviors related to time perspective, sensation-seeking, and boredom. However, there are several areas where such roles and links are not entirely clear and further research is much needed to verify and expand on the actions of these molecules and how they relate to human behavior.

Although time perspectives are well-defined and separated from each other conceptually, they are still very subjective within each individual. Because time perspectives are so dependent on positive or negative affect, which can fluctuate drastically over time depending on current situations and general mood, it is unreasonable to assume that people are always set in one time perspective. Often, these perspectives change and it can be difficult to say for certain whether a person has an overall tendency to experience a specific perspective. There is even some evidence that a person can experience multiple perspectives at the same time (Zimbardo & Boyd, 1999). Thus, although there is evidence that time perspective is related to affect, more research is needed to fully understand the relationship between the two. Furthermore, it makes enough sense that negative perspectives correlate with negative affect. However, some of the correlations are not quite as defined. For example, if a person has high positive affect, what should determine whether he or she has past-positive, or future, or present hedonistic time perspectives? Those blurry relationships need to be further researched to understand both the biological and psychological connections between affect and time perspective.

One such psychological question to ask is that of motivation: What is it that allows a person with high positive affect to focus on the future rather than on the past? Also, what differentiates the negative-past perspective from the risk-taking present-hedonistic perspective (Zimbardo & Boyd, 1999)? What psychological processes and heuristics provide the bases for such individualized distinctions? For example, Vodanovich (2003) mentions that BP scores are correlated with higher value of external rewards, which explains the increased sensation-seeking tendencies. However, the relationship with internal rewards (e.g., achievement of long-term goals) is less clear. Biological causes of behaviors caused by desire for intrinsic rewards may be difficult to uncover due to the longer-term nature of such behaviors. However, it may be possible that the neurotransmitters dopamine and serotonin may play a role in the psychological states which promote long-term intrinsic motivation. What may be useful is looking at emotional affect as a variable with varying degrees of intensity, rather than as simply positive or negative. A relationship may be found between scores on an affect spectrum and time perspective tendencies. Such a connection may lead to further understanding of how biology may influence long-term motivation.

Again, much research needs to be done on the causal relationships between affect, cognition, boredom and time perception, especially in the context of biological factors related to the 5-HT serotonin receptors. Answers to the questions raised by such complicated relationships could be of great benefit in the medical and therapeutic fields. More research could also be done on both the psychological and biological factors of how cognition and need-for-cognition influences boredom.

On the subject of gonadal hormones as related to sensation-seeking, it was mentioned above that androgen and estrogen are both positively correlated with the Dis and TAS subscales of the SSS (Daitzman & Zuckerman, 1980). However, androgen actually is a natural inhibitor of MAO production (Ou, Chen, & Shih, 2006), which is contradictory to the role of MAO on sensation-seeking. This suggests, as would be expected, that there are more factors influencing sensation-seeking than just MAO levels and affect. There are likely several biological processes that come together to collectively result in any particular level of sensation-seeking tendencies. For example, not only does it matter whether someone is male or female and at what rate they produce MAO, it also matters how much of each type of neurotransmitter they have, where those neurotransmitters are concentrated in the brain, what other inhibitors and protagonists are present, and how those things influence neurotransmitter and MAO levels.

Expanding on this issue of gender differences, the biological differences affecting behaviors of men and women also need to be further explored. Differing levels of gonadal hormones undoubtedly influence the biopsychological processes of sensation-seeking and time perception, and it seems that the comprehensive role of these hormones in such a context are poorly understood.

The conclusions drawn from this review will hopefully gear future empirical research towards finding a biological network which controls for boredom, sensation-seeking, and overall motivation. Such findings may play a significant role in altering clinical treatment and counseling methods for individuals displaying addictive sensation-seeking behaviors.

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