



Impact of Emotional State on Impulsivity in Adolescence

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Abstract

Teenagers' impulsivity is linked to the underdevelopment of the prefrontal cortex. Using delayed gratification techniques, one can test impulsive actions and test an individual's ability to resist a small immediate reward in order to receive a better reward later. Most research in this field has focused on delayed rewards when it comes to food (for rats) and money (for adults). Adolescents, while being known as the most impulsive, have rarely been tested in this manner. Not only that, the experiments that did test adolescent impulsivity treated adolescence and adult decision-making the same, despite the fact that the adolescent brain is still undergoing development in important decision-making structures while the adult brain is more stable. Adolescents (15-18) also have unique experiences because they are in the transition phase of childhood to adulthood. Therefore, many of their values are more centered around academics, friends, and social media than adults (over 21). While the data found in this study was inconclusive, it leads to further questioning of if and why, in a state of dysphoria (negative affect) or anhedonia (lack of pleasure) adolescents have been found to prefer the smaller immediate rewards over the larger delayed rewards. It goes through all hypotheses and relates dopamine activity or weaker/less developed brain structures including the ventral tegmental area (VTA), nucleus accumbens, orbitofrontal, and the anterior cingulate cortices with reasoning behind adolescent decision-making. This study inspires further research on the extent of adolescent impulsivity when in a state of dysphoria (negative affect) with results more centered around adolescent experiences unlike the research conducted before it.

Evolutionary Hypothesis Behind Simple and Complex Decisions

The goal of the study was to explore how emotional states will shift adolescent impulsivity towards immediate small rewards over delayed larger rewards. Within this study, the preference of smaller immediate rewards is classified as an impulsive act. The accumulation of impulsive actions will lead an individual to be classified as impulsive.

Pleasure has an evolutionary advantage to push an organism towards a certain behavior to increase fitness. Fitness increases an individual's ability to increase survival of their bloodline (Berridge 2003). Individuals no longer have the same push to pass on genetics. Reproduction has evolved from a biological necessity towards a choice. However, despite this, pleasure and displeasure still have an extreme impact on decision-making. When making a decision, people prefer the option that increases the most amount of pleasure (Dresp-Langley B 2023).

When decisions become more advanced from "good" or "bad" the process of deciding becomes more complex. Often most decisions are not entirely good or bad. The complexity of the decision comes from deciding which option will create the most amount of pleasure. Typical pleasure promoters include food, friends and loved ones, music, and art. The presence of these pleasure promoters, although subjectively weighted, increase the preference of an option.

Biological Hypothesis Behind Decision Preferences

When an individual is in a state of adonia, a severe state of dysphoria and often depression, they often experience very low dopamine activity in the brain (Cooper 2018). A state of dysphoria is also referred to as a negative affect. Negative affect is a psychological term for a general experience of unpleasant emotions. These unpleasant emotions can range from sadness, anger, discomfort, guilt, and more (Dresp-Langley B 2023). Currently, it is unclear whether adolescents will be more likely to be classified as impulsive when in a state of dysphoria. Specifically, we examined preference for immediate rewards due to known rapid dopamine release during pleasurable experiences (Elsevier 2015). In this impulsive state they are less likely to perform a proper cost-benefit analysis of long term gain. Priorities become narrowed to a “what will make me feel better now” mindset.

Subjective processing of pleasure prioritizes present needs rather than the future. These immediate rewards are immediate. For example, an immediate reward would be the automatic access to your phone for a specific amount of time. A delayed reward would require a period of waiting before access to the reward. The waiting period could last from a week or longer.

Pleasure in the brain is dependent on a lot of different brain components. The mesocortical limbic circuitry is a central component for the processing of pleasure, reward and motivation. It is primarily controlled by the neurotransmitter, dopamine. The mesocortical limbic circuitry system is composed of the ventral tegmental area, nucleus accumbens, and the prefrontal cortex. The ventral tegmental area is the midbrain hub where most dopamine receptors originate. The nucleus accumbens is a part of the limbic system that controls pleasure, desire, and reinforcement. The prefrontal cortex governs executive functions, decision-making, and emotional control (Berridge 2015).

Consent Methodology

The study distributed a survey to 21 adolescents (15-18) to measure the impact of emotional state on impulsivity. Impulsivity is measured by the preference of smaller immediate rewards in comparison to larger delayed rewards. The emotional state of the participants will be separated into positive, neutral, and negative mood conditions. The positive condition survey will tailor the experimental portion to evoke positive emotions. The negative condition survey will do the same to evoke negative emotions. The neutral condition will do its best to remain neutral to act as the control.

The survey was made on Google Forms. The survey is split into 6 parts. There is a minor pre-brief portion that gives general information about the survey. This includes an overview of the basic structure, content, and purpose of the survey. Essentially, it gives enough information for proper informed consent/assent.

In order to get parental consent for minors, the minors were instructed to contact their parents or guardians. The survey given to the minors has a link that needed to be submitted

before the minor could continue the rest of the survey. In order to give informed assent, the parent or guardian will read a brief explanation of the survey. It will address any ethical concerns. Names of the parent and child were collected only for the purpose of keeping track of consent. These names will remain entirely confidential and will only be available to reviewed researchers of the project. None of the participants' names are publicly mentioned or analyzed by the researcher.

The following section will be a personal data section used for generalizability. The data collected in this section was only used to see if the data collected is diverse enough to be applied to a greater population. The personal data included gender, race, and age. It was not used to identify any of the participants because names were not tied to their responses. The data being collected that will be reported in the study will be condensed to average percentages. No individual response will be isolated, instead each condition will be condensed into average responses.

Experiment Methodology

The experimental portion begins after the above is completed. The experimental portion begins with a series of images tailored toward the experimental condition. Following image analysis, a portion that incorporates questions from the PANAS (Positive and Negative Affect Schedule) survey begins (Heubeck 2021). The survey ends with a questionnaire section that has questions framed to make participants pick between smaller immediate rewards versus larger delayed rewards, and finally a short debriefing section at the end. The survey has three variations for the three experimental conditions. Condition A is the positive mood condition. Condition B is the negative mood condition. Condition C is the control condition. Each experimental condition has a tailored variation of photos but the rest of the survey remains identical.

The first experimental section will show pictures that aim to evoke or enhance certain emotions based on the experimental condition. Condition A will show the participants three positive photos in an attempt to enhance positive emotions. Condition B will show three negative images to enhance negative emotions. Condition C will not include any images. The section is skipped and moves on to the next. The participants in the conditions with the photos are prompted to analyze the images, which includes verbally or mentally recognizing possible sensory information that the image evokes.

The participants will then be led into a rendition of the PANAS (Positive and Negative Affect Schedule) survey (Heubeck 2021). This portion aims to test whether or not the images skewed the participants toward more positive or negative emotional states based on the images shown. This will be done by taking the average percentages of positive and negative affects and comparing the data in each experimental condition. The participants will answer the same questions as the PANAS survey and the student researcher will input the anonymous answers into the actual PANAS survey. If the participants wish to receive their results, they are encouraged to email the researcher.



The last experimental section of the survey asks a series of “this or that” questions. These questions are created with one option being a short term reward and the other being a long term more valuable reward. Assuming successfully enhanced emotions, which is tested by the second portion, the data in each experimental condition will be compared with one another. Based on statistics of perceived emotion, the data will be analyzed for trends. The researcher will look for similarities between the answers in each condition. For example, if Condition A usually prefers the long term rewards and Condition B prefers the short term rewards. The researcher will then use this data to state the impact of emotional state on impulsivity in adolescence.

The questions are also sectioned into three common categories adolescents experience; friends, academics, and social media. The researcher will observe commonalities and differences to see if impulsivity is heightened in a certain section. Each category has four questions to make the data even.

Each category has at least one base question that is modified in a way that either lessens the short term reward or elongates the time until the long term reward. For example, one question asks, “Would you rather spend time with your friend for 30 minutes today or spend 2 hours with them over the weekend?”. The following question asks, “Would you rather spend time with your friend for an hour today or spend 2 hours with them over the weekend?”.

Once the data was collected, the researcher took the average response of the PANAS survey, percent impulsivity for the totality of each condition, the percent impulsivity for the categories and the percent impulsivity for each question. It was then tied into a possible hypothesis of what could be happening in the pleasure control systems and emotional systems in the brain.

Participant Recruitment and Debriefing

Participant recruitment was done by distributing the survey link on the researchers personal instagram account. Those who wanted to take the study reached out to the researcher and the link was sent to them. The researcher created a script that was stated to all possible participants.

The survey ends with a debriefing statement. Some of the information in this statement can not be included in the initial statement because of the risk of social desirability bias, where the participants will tell the experimenter what they want to hear.

In the case that the survey triggered strong emotions, there was a list of hot lines at the end of the survey for support.

Data

The portion of the survey that borrowed from the PANAS survey to measure affect of the individuals yielded statistically insignificant results. Affect is a psychological term that measures an individual's own emotional state as well as their ability to access others' emotional states.

Condition A, when combining all individual data sets, yielded a positive affect of 33 and a negative affect of 24.4. The PANAS affect scale ranges from 10-50. Therefore, the positive affect for Condition A is slightly higher than moderate. The negative affect is around moderate levels but is slightly higher than what the PANAS survey classifies as normal. Condition C, the control condition, has a positive affect sum of 32.6 and a negative affect sum of 22.1. Condition B had a positive affect sum of 31.4 and a negative affect sum of 27.9. This data was condensed into a graph, labeled Figure 1.

PANAS Results

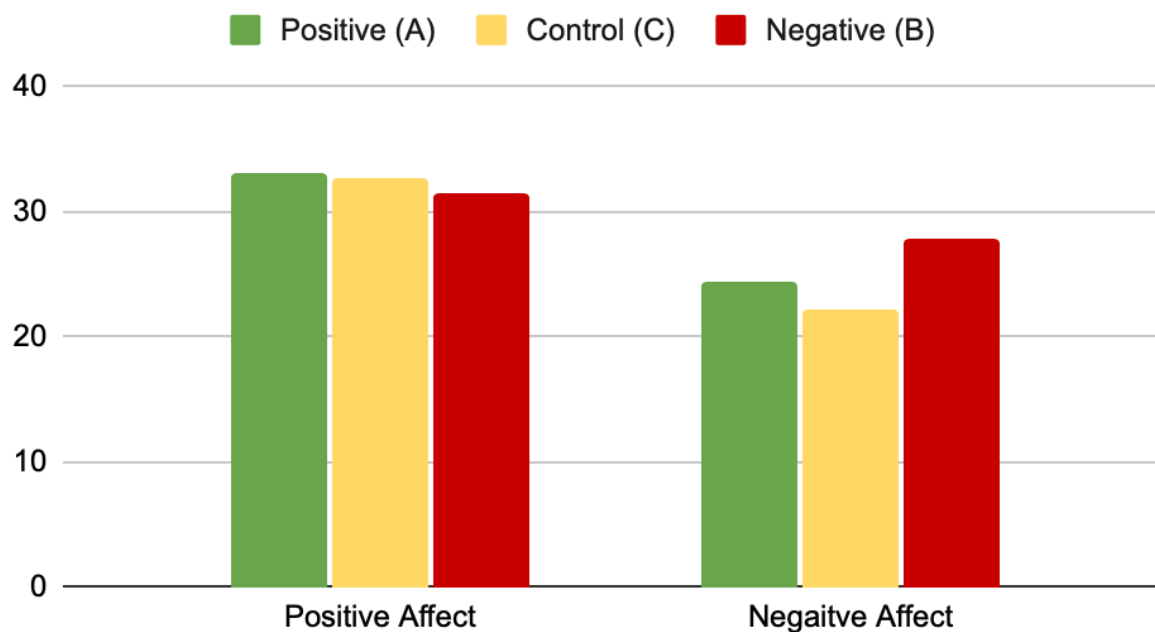


Fig 1: This table demonstrates the Positive Affect and Negative Affect sum results from the PANAS survey for the 3 conditions.

Figure 1 shows that each condition has no difference in positive affect. The negative affect shows an increase in negative mood for Condition A and Condition B. Therefore, the attempt to manipulate the mood of the participants was not effective. Nonetheless, Condition B did demonstrate a slightly more negative mood, Condition A was the second most negative, and Condition C was the least negative.

The following section of the survey analyzed the preference of impulsive actions. The average response impulsivity was calculated by finding the mean percent of participants who picked the impulsive action for each question. The sum of the impulsive percentages was taken for all 12 questions.

This condensed average of impulsivity demonstrates a trend that refutes the hypothesis. The results were not statistically significant because the standard deviations overlap. Condition A, in total, chose the impulsive decision 42.858 percent of the time. The percentage of impulsive actions will later be referred to as IMP. Condition C chose on average 45.233 IMP. Condition B had an average of 39.29 IMP.

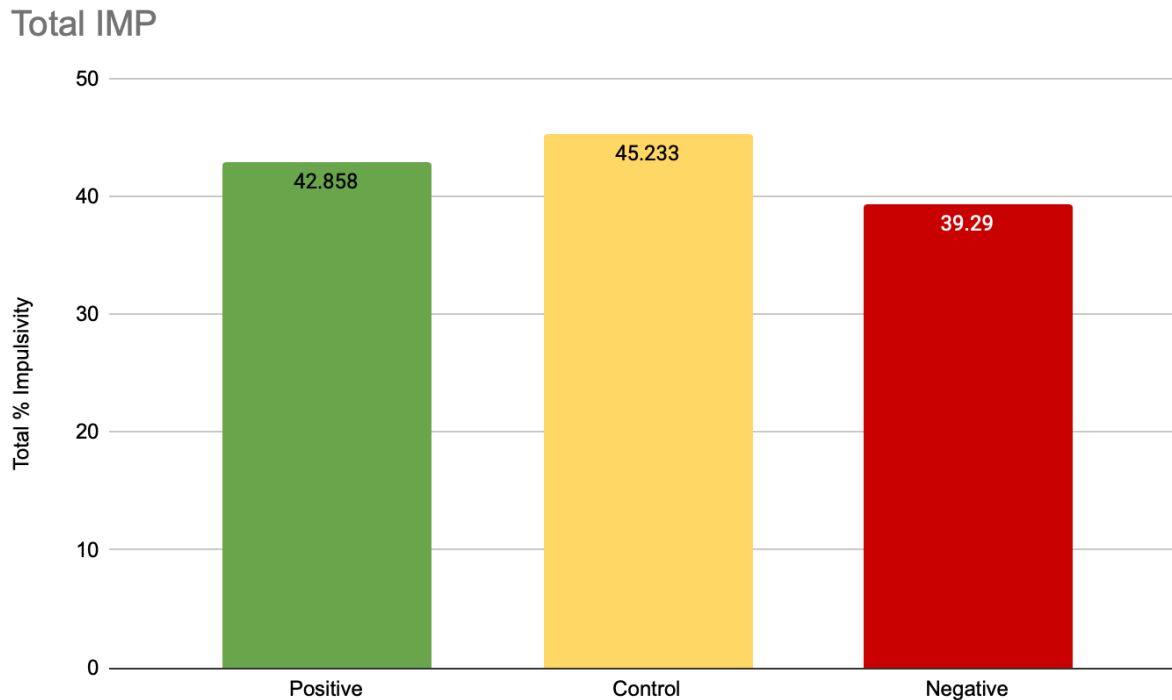


Fig 2: This graph demonstrates the calculated average percentage of impulsive decisions for all questions in the 3 conditions.

Though the difference was not significant, the data showed a decrease in IMP for the most negative affect condition. Similarly, the control, though unintentionally, ended up being the condition with the smallest negative affect sum and it has the highest IMP. Therefore, even though the data was not significant enough to draw an absolute conclusion, there is a slight trend that supports the ulterior hypothesis; negative mood decreases impulsivity.

The questions were also separated into 3 categories to measure impulsivity in different aspects of adolescents' lives. The categories included friendships, academics, and social media. Figure 3 shows the IMP for each category. The data was found by taking the average percentages of impulsivity for each question in the category. Each category had 4 questions.

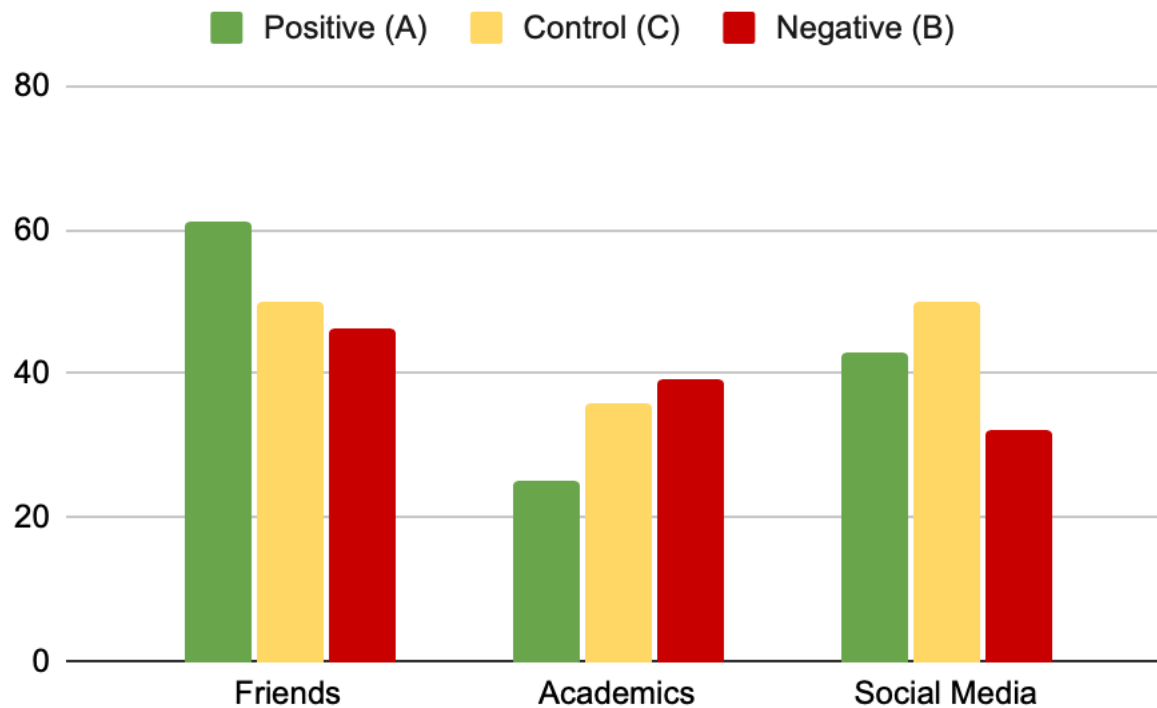


Fig 3: This graph shows the average percentage of impulsive decisions for the 3 categories: friends, academics, and social media for the 3 conditions.

The data supports a trend that differs from the trend that the total IMP demonstrated. The subcategory of friendship showed probably the most notable difference between each condition. Condition A was more impulsive than the other conditions when it came to friendships. Although, this data cannot be attributed to mood because Figure 1 demonstrates that Condition A was between Condition B and C when it came to negative affect. Friendship questions also led to a higher percentage of impulsivity than either academics or social media. Academics had the lowest amount of impulsive decisions. Social media followed the same trend as the total IMP. Condition C, the one with the lowest negative affect sum, participated in impulsive decisions more than the other conditions.

The data was also analyzed for each question. The twelve questions are listed in Figure 4. The questions are ordered exactly how they appear in the survey. Question 1-4 represents the friendship tailored questions. Questions 5-8 are the academic sub-category. Questions 9-12 are related to social media. Figure 5 represents the IMP for each Condition in all 12 questions.



	Question	Impulsive Option	Delayed Option
Question 1	Would you rather spend time with your friend for 30 minutes today or spend 2 hours with them over the weekend? (Assuming today is Monday)	Spend 30 minutes with my friends today	Spend 2 hours with them over the weekend
Question 2	Would you rather spend time with your friend for an hour today or spend 2 hours with them over the weekend? (Assuming today is Monday)	Spend an hour with them today	Spend 2 hours with them over the weekend
Question 3	Would you rather not see your friend for a whole month but be able to go on a 3 day vacation with them at the end or see them once a week?	See them once a week	Wait the month for the 3 day vacation
Question 4	Would you rather not see your friend for a year but be able to go on a two week long vacation at the end?	See them once a week	Wait the year for the two week vacation
Question 5	Would you rather study for two days straight but be guaranteed a 100% on the next test or study for an hour and be guaranteed to get a B?	Study for an hour and be guaranteed to get a B	Study for two days straight and be guaranteed a 100%
Question 6	Would you rather study for two days straight but be	Study for an hour and be guaranteed to get a C	Study for two days straight and be guaranteed a 100%



	guaranteed a 100% on the next test or study for an hour and be guaranteed to get a C?		
Question 7	Would you rather study for two days straight but be guaranteed a B on the next test or study for an hour and be guaranteed to get a C?	Study for an hour and be guaranteed to get a C	Study for two days straight and be guaranteed a B
Question 8	Would you rather study for a week straight but be guaranteed a 100% on the next test or study for an hour and be guaranteed to get a B?	Study for an hour and be guaranteed to get a B	Study for a week straight and be guaranteed a 100%
Question 9	Would you rather FaceTime one friend for 10 minutes right now, or wait until tonight and group FaceTime with all your friends for an hour?	FaceTime one friend for 10 minutes	Wait until tonight for group FaceTime
Question 10	Would you rather post the photo you took on vacation right now or wait until the end of your vacation to do a full vacation post?	Post it right now	Wait until the end for a full vacation post
Question 11	Would you rather scroll TikTok for 15 minutes right now or be able to have full access to TikTok the	Scroll TikTok right now	Wait to have unlimited access over the weekend

	entire weekend? (Assuming today is Monday)		
Question 12	Would you rather scroll TikTok for 15 minutes every day of the week or be able to have full access to TikTok the entire weekend?	Only have access to social media for 15 minutes a day	No access during the weekdays but unlimited access over the weekend

Fig 4: This table lays out the questions asked to the participants in the survey. It labels the two choices that were given the participants as either impulsive for delayed.

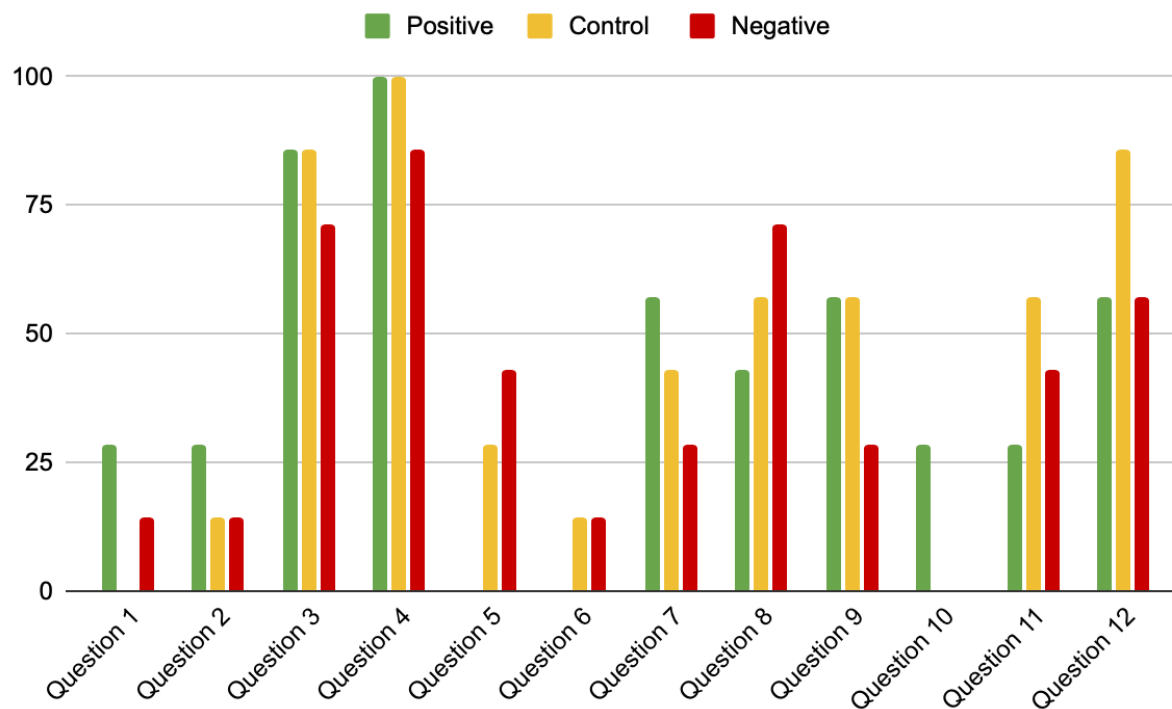


Fig 5: This graph shows the average percentage of impulsive decisions for the individual questions for the 3 conditions.

Question 1, 2, and 7 support Condition A (positive) being the most impulsive. Question 3, 4, and 9 have Condition A and C behaving the same while Condition B is less impulsive. Question 5 and 8 are the only questions where Condition B is the most impulsive. Essentially, each question supports a different hypothesis. Therefore, there is no conclusive hypothesis that can be tied to the data.

However, it can be seen that questions 3, 4, and 12 were the questions that led to the most impulsive decisions. Question 3 and 4 fall under the friendship category. This suggests

that adolescents may be more impulsive in friendships in comparison to other subcategories of their lives.

Results and Next Steps

The data collected in the survey led to inconclusive results. It appears that all hypotheses have been supported by certain aspects of the survey. This inconsistency could be used to support the hypothesis that mood has no effect on impulsive decision making. Due to the limitations in the study (detailed below), the data is not statistically significant and provides an inconclusive result.

Firstly, the study emphasized the importance of providing an apt amount of participants. In total, the survey consisted of 21 individuals ranging from 15-18 years old, giving only 7 individuals per condition. Additionally, this data set would have benefited from more participants and sampling coming apart from the researcher's personal Instagram account. All individuals attended the same school. The majority of the participants were female. Therefore, diversity in the data set was absent so it can not be generalized to a larger population. And, because of the limited sample, there was insufficient data to conclude a hypothesis even for this localized population

The survey would have benefitted if it was more controlled.

The survey was only distributed digitally, therefore, the environment that the survey was taken in differs from individual to individual. This leads to the possibility of confounding variables that could not be measured. One way, if the study were to be repeated, it could have been more controlled is to take the survey in the same environment for all participants. For example, a classroom could have been an example of a controlled environment because everyone would have taken it at the same time in the same environment.

The survey's lack of significant results showed how variable decision making is between teenagers. It shows that some individuals, whether because of genetics or environment, naturally act more impulsive. These people cannot be compared against one another due to these genetic and environmental differences. It would have been more beneficial, in order to answer the original question, to distribute all 3 conditions of the survey to the same 21 individuals. This would have removed any variables that have to do with possibilities of a naturally more impulsive person. It would have also created more data points which could be compared against one another. If the participants took all 3 surveys the differences in their responses could be more accurately compared to the differences in mood.

Mood change control was also compromised. As shown in Figure 1, the positive affect of all 3 conditions remained the same. Figure 1 also demonstrates that Condition A, which was supposed to be the positive mood condition, had a slightly higher negative affect sum than the control (Condition C). Due to the fact that participants were not monitored, there is no proof they fully followed the directions. Some participants could have scrolled through the images and did not give time for the experimental part to manipulate their mood. A controlled environment could have ensured proper use of the photos to manipulate mood.

If the researcher were to repeat the experiment, these changes would hopefully produce more clear and statistically significant results that support the original question.

No Correlation Hypothesis

In the case that the data had repeated itself and there were no apparent connections between mood and impulsivity, it could be hypothesized that impulsivity is actually a multifaceted phenomenon. It could demonstrate that impulsivity is not solely related to mood. Instead, it could reveal that impulsivity is uncontrolled due to the differences in attachment and coping strategies.

Negative Correlation Hypothesis

If the data shows a negative correlation between impulsivity and mood, the researchers' original hypothesis would be supported. It would show that adolescents make decisions based on pleasure and displeasure. The negative affect that is evoked by the images could be tied to very low dopamine activity in the brain (Dresp-Langley B 2023). This dopamine activity would have to be researched independently. If the low dopamine activities correlated with higher impulsivity it could be concluded that the preference for immediate rewards was due to known rapid dopamine release during pleasurable experiences. These immediate rewards are something pleasurable. Therefore, in the brain's constant quest towards pleasure, adolescents would be more likely to choose these actions when experiencing a negative affect (Elsevier 2015). In this impulsive state they are less likely to perform a proper cost-benefit analysis of what will be helpful for them in the long run. Priorities become narrowed to a "what will make me feel better now" mindset. This could lead to issues with long-term decision making. If this is the case, researchers would have to continue the experiment to combat possibly damaging impulsive decisions.

Positive Correlation Hypothesis

On the contrary, if a positive mood leads to more impulsive decisions, the alternative hypothesis would be supported. The people in these positive affect moods would be experiencing high levels of dopamine activity. In this case, they are already experiencing a pleasurable experience. They do not need to proceed in the quest for pleasure. However, the possibility that their actions will cause harm appears to be minimal. They are already at such a high, that the possibility of something diminishing it seems to be inconsequential. Therefore, they may lean more towards the impulsive choices. To summarize, instead of this preference being due to the want for pleasure, it is actually due to their inability to fully understand and analyze the downsides.



Conclusion

The hypotheses listed above are purely speculative. If these hypotheses were to be supported, there would have to be a portion added on to the experiment that analyzed brain and dopamine activity.

Regardless of all of these weaknesses, this study provided the basis for further research.

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