Mood and Reward Sensitivity in Children, Adolescents, and Adults: A Fuzzy-Trace Theory Approach

Steven M. Estrada (Cornell University), Valerie F. Reyna (Cornell University), Britain A. Mills (Cornell University), Seth T. Pardo (Cornell University)

Cornell University

Abstract

Recent theories propose that adolescents demonstrate increased sensitivity to reward (relative to children and adults), producing risk-taking. However, under controlled conditions of choice between sure and gamble options in both gain and loss frames, risk-taking declined with age. As reward increased, children took more risks, but adolescents and adults took fewer risks. Gender differences were observed only for children; males were more risk seeking. In addition, negative mood increased verbatim-based analysis for all groups.

Adolescent Risk-taking

- When compared to adults, adolescents take more risks both in behavioral data and in laboratory tasks (CDC, 2003; Gardner and Steinberg, 2005).

- Several theories explain the increased prevalence in risk-taking during adolescence as being due to an increase in the sensitivity to reward. (Steinberg, 2008; Casey, 2008).

  - The same task has rarely been administered to children, adolescents, and adults. Administering the same task would help to remove confounding variables (such as opportunity) and evaluate the reward sensitivity hypothesis.

  - If the reward sensitivity hypothesis is true, an increase in preference for a risky option should increase from childhood into adolescence, followed by a steady decline into adulthood.

- Fuzzy-trace theory offers that adolescent risk-taking is not due to an increase in reward sensitivity, instead offering that adolescents are in a unique transition period from verbatim-based analytic processing to gist-based intuitive processing. (Reyna & Farley, 2006).

  - Adolescents should be showing a shift from analytic processing of risk (increasing risky choice) to a more mature qualitative processing of risk. Therefore, their pattern of choice behavior should begin to resemble adults.

Emotion
- Emotion has been revealed to be an important aspect of mature decision making (Damasio et al, 1994; Rivers, Reyna, & Mills, 2008)
- Studies have found positive mood to be related to relational (i.e. gist-based) processing, while negative mood increases item-specific (verbatim-based processing (Storebeck & Clore, 2004).

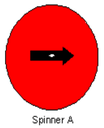
Hypotheses:
- Adolescence is not characterized by increased reward sensitivity, instead, adolescence is characterized by a shift from analytic-based processing favored in childhood to more gist-based intuitive processing, favored in adulthood.
- Positive mood facilitates gist-based intuitive processing, while negative mood facilitates verbatim-based analytic processing.

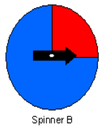
Method

Participants

- 24 Second Graders, 21 Adolescents, 39 Young Adults

Framing Task


Spinner A


Spinner B

- Adults, adolescents, and children were presented with 18 gambling scenarios
-Participants were asked to make a choice between a spinner representing a sure option and a spinner representing a gamble option.
-Gamble was created by factorial combination of 3 levels of risk (1/2, 1/3, 1/4) and 3 levels of outcome magnitude (Low, Medium, High).
-Expected values were equivalent across option
-Each choice were presented as a gain or as a loss
-Presented in 2 blocks, 9 choices per block
-Blocks counterbalanced across subjects

Gain Frame: You have a choice. If you pick this side [Spinner A], you win $5 for sure. If you pick this side [Spinner B], you take a chance. If the spinner lands on red, you win $20, if the spinner lands on blue, you win nothing. What do you want to do, win $5 for sure or take a chance, maybe win $20, maybe win nothing?
Loss Frame: I am going to give you $20. You have a choice. If you pick this side [Spinner A], you lose $15 for sure. If you pick this side [Spinner B], you take a chance. If the spinner lands on blue, you lose $20. If the spinner lands on red, you lose nothing. What do you want to do, lose $15 dollars for sure, or take a chance, maybe lose $20 maybe lose nothing?

Adapted from Reyna & Ellis (1994)

Mood Manipulation

-Prior to each block, participants are shown a movie clip previously shown to induce an affective state.
- -Positive mood induction
  - -1 minute 23 second clip of penguins playing
- -Negative mood induction
  - -1 minute 19 second clip from the movie Bambi, depicting Bambi's mother dying.
- -Neutral mood Condition
  - -1 minute 20 second film clip showing a repeating pattern of sticks

Fredrickson & Branigan, 2005; Gross & Levenson, 1995

Results

Results were analyzed using a mixed-measures analysis of variance. Included in the model were Sex, Age Group, Condition (Positive, Negative, Neutral), Condition (Gain First, Loss First) and the within-subjects factors of Frame (Gain, Loss), Risk of negative outcome (.5, .67, 75), and Reward (Low, Medium, High). Presented are main effects and higher order interactions that qualified main effects.

Figure. 1. As risk of the negative outcome increased, participants chose the gamble less often

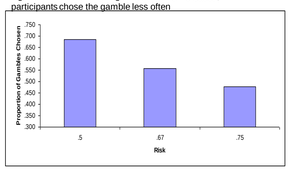
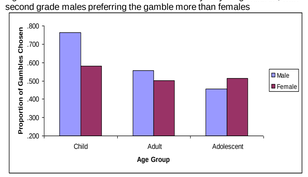


Figure 2. A sex difference in choice was seen only for young children, with second grade males preferring the gamble more than females



Figures 3, 4, and 5. A significant two-way interaction between Age and Magnitude was qualified by a three-way interaction with frame. Both adults and adolescents showed a greater preference for the sure option as the magnitude of the reward increased. Second graders, however, showed a preference for the gamble as the magnitude of the reward increased, indicating a greater sensitivity to reward. Second graders also show a reverse framing pattern, indicating quantitative processing. Adolescents and adults do not show this pattern, instead preferring to process their options qualitatively, indicated by the standard framing pattern.

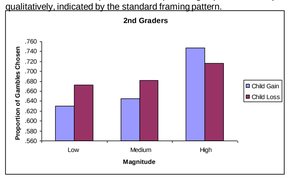


Figure 4

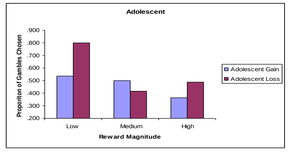
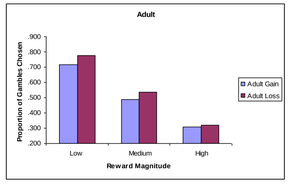


Figure. 5



Figures 6, 7, 8, 9, 10, and 11. A four-way interaction was found between Age, Condition , Frame and Risk. Testing the three-way interaction of Age, Frame, and Risk across the three different mood conditions revealed a significant three-way interaction only for the negative mood condition. The overall pattern of results suggests an increase in quantitative processing when in negative mood, as indicated by the greater frequency of a pattern of reverse framing.

Figure. 6

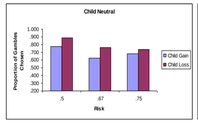


Figure. 7

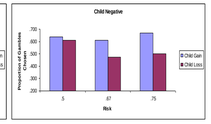


Figure. 8

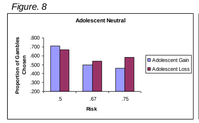


Figure. 9

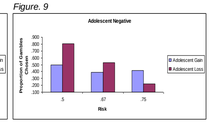


Figure. 10

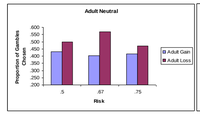
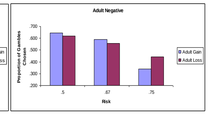


Figure. 11



Discussion

Overall, our results do not support the reward sensitivity hypothesis. As seen in figures 3-5, adolescents did not favor the larger magnitude rewards as the second graders in our sample did. Instead, their pattern of choices more closely resembled adults, with an increase in favoring the surer option as the magnitude of rewards grew larger. This supports the fuzzy-trace idea that adolescents are in a transition stage from quantitative analysis in childhood to more gist-based qualitative decision making favored by adults.

In addition, negative mood enhanced quantitative processing, as illustrated in figures 6-11. The overall pattern shows that when framing patterns in negative mood are compared to framing patterns in neutral mood, standard framing patterns are ameliorated or in some cases even shift to a reverse framing pattern. This effect was smallest for adults, possibly due to greater experience in mood regulation.

This study examined decision making in a standard framing task across three age groups. Of importance, the same task was administered to children, adolescents, and adults, which allows comparisons of sensitivity to reward. The pattern of choices found for adolescents does not support the idea that adolescents are more sensitive to reward. Instead the pattern suggests that adolescents are in a transition period between verbatim-based analytic processing to gist-based intuitive processing.

References

Casey, B. J., Getz, S., & Galvan, A. (2008). The adolescent brain. *Developmental Review, 28*, 42–77.

Center for Disease Control (2005). *Youth risk behavior surveillance*, (MMWR, June, vol. 55, Publication No. SS-5)

Damasio A., Damasio, H., Tranel, D., & Bechara, A. R., (1994). Deciding advantageously before knowing the advantageous strategy. *Science*, 275(5304), 1293-1295.

Gardner, M., & Steinberg, L. (2005). Peer influence on risk taking, risk preference, and risky decision making in adolescence and adulthood: An experimental study. *Developmental Psychology*, 41, 625–635.

Reyna, V. F., & Ellis, S. C. (1994). Fuzzy-Trace Theory and framing effects in children's risky decision making. *Psychological Science, 5*, 275-279.

Reyna, V.F., & Farley, F. (2006). Risk and rationality in adolescent decision making: Implications for theory, practice, and public policy. *Psychological Science in the Public Interest, 7*, 1–44.

Rivers, S. E., Reyna, V. F., & Mills, B. A. (2008). Risk taking under the influence: A fuzzy-trace theory of emotion in adolescence. *Developmental Review, 28*, 107–144.

Steinberg, L. (2008). A social neuroscience perspective on adolescent risk-taking. *Developmental Review, 28*, 78–106.

Storbeck J., & Clore, G. L. (2005). With sadness comes accuracy; with happiness, false memory. *Psychological Science*, 16(10), 785-791