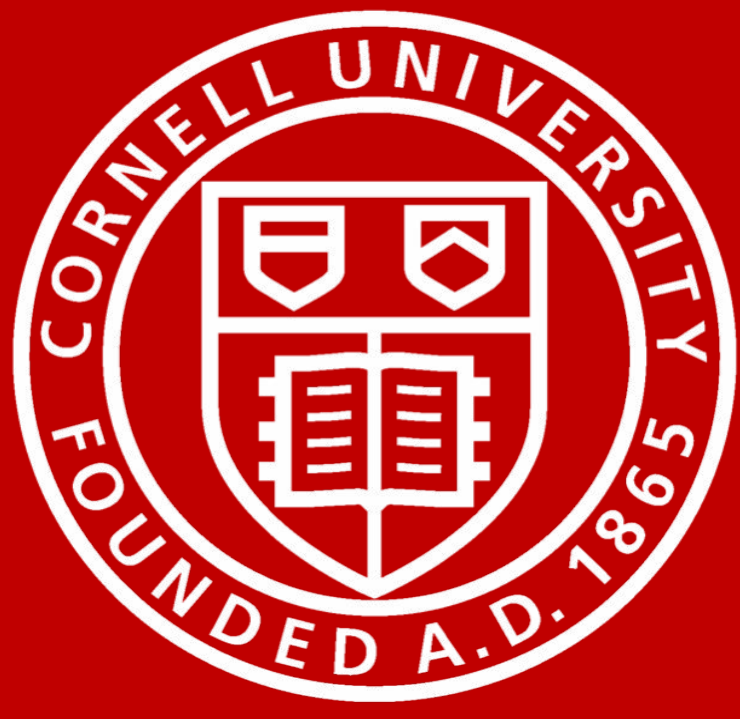# Age and Hunger Interact in Reward Valuation

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Introduction

- Heightened reward sensitivity, often measured through neural reactivity in reward-related areas of the brain such as the ventral striatum, is often cited as a hallmark of adolescence (e.g. Galvan, 2013), although such findings have not been unanimous (e.g. Bjork et al., 2010).
- Developmental differences in valuation of rewards has been offered as a potential explanation for heightened sensitivity to reward during adolescence (Barkley-Levenson & Galvan, 2014), although risk and reward are often not evaluated separately in experimental tasks, creating ambiguity in interpretation.
- Reward valuation typically follows a concave pattern for gains (e.g. Ciranka & van den Bos, 2019; Kahneman & Tversky, 1979), but how age and hunger together influence this pattern is not as well understood. Further, experiments examining developmental differences in reward valuation often evaluate a relatively narrow range of magnitudes (e.g. Insel & Somerville, 2018).
- In this experiment, we examined *age and hunger effects* on ratings of monetary rewards from $1 to $60 separated into three distinct magnitudes. Critically, we used a task that separates risk from reward sensitivity and controls for known developmental differences in learning and memory.
- With respect to reward ratings, age interacted with magnitude in a diverging fan such that adolescents rated higher magnitude rewards higher than adults but differences were not observed between the age groups at lower magnitudes. Hunger also interacted with magnitude in a converging fan such that the hungry group rated lower magnitudes of reward lower than the non-hungry group but differences were not observed between the groups at higher magnitudes. Age and hunger did not interact together with magnitude.
- However, prior work shows that adolescents are particularly sensitive to *differences in reward magnitude*, controlling for the ratio of outcomes as contrasted by their difference (e.g. Reyna et al., 2011).
- We used *difference scores of reward ratings* to examine the effect of age and hunger on responsiveness to reward. Age and hunger did interact with reward magnitude once difference scores were presented.

Methods

- 132 participants were recruited from two age groups: 69 adolescents and 63 adults. Approximately half of the subjects were randomly assigned to the hunger condition (fasted for at least 4 hours).
- Reward ratings for monetary rewards from $1 to $60 were provided at 3 magnitudes (low, medium, and high) with 4 variations within each magnitude.
- Participants gave ratings for rewards on a 21-point scale.
- Liking vs. Wanting and Right Now vs. In General of each amount of money produced 4 types of judgments, leading to 12 distinct difference contexts.
- Difference scores were determined by subtracting the reward rating of the lowest amount from the reward rating of the highest amount within each magnitude.
- Incentive compatible design.
- We used a 3 (magnitude) x 2 (Right Now or In General) x 2 (Liking or Wanting) repeated-measures ANOVA to analyze monetary reward difference scores, with age and hunger groups as between-subjects factors.

Results

Interaction of Age, Hunger, and Reward Magnitude
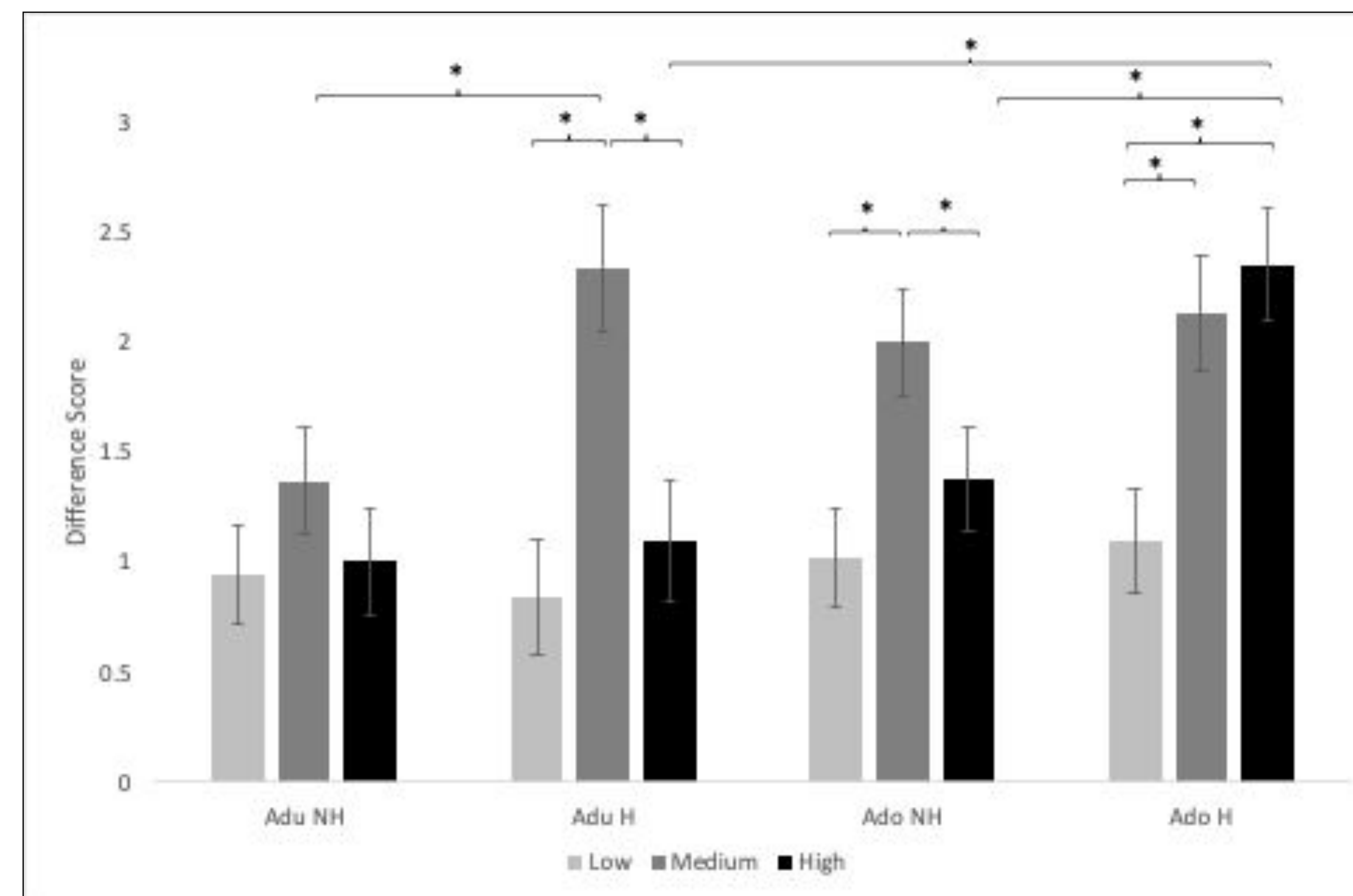

lowest motivation →→→ highest motivation

Figure 1. A three-way interaction effect of age group, hunger group and reward differences. NH = Non-hungry and H = Hungry, Ado = Adolescents and Adu = Adults. Error bars represent +/- 1 SE.
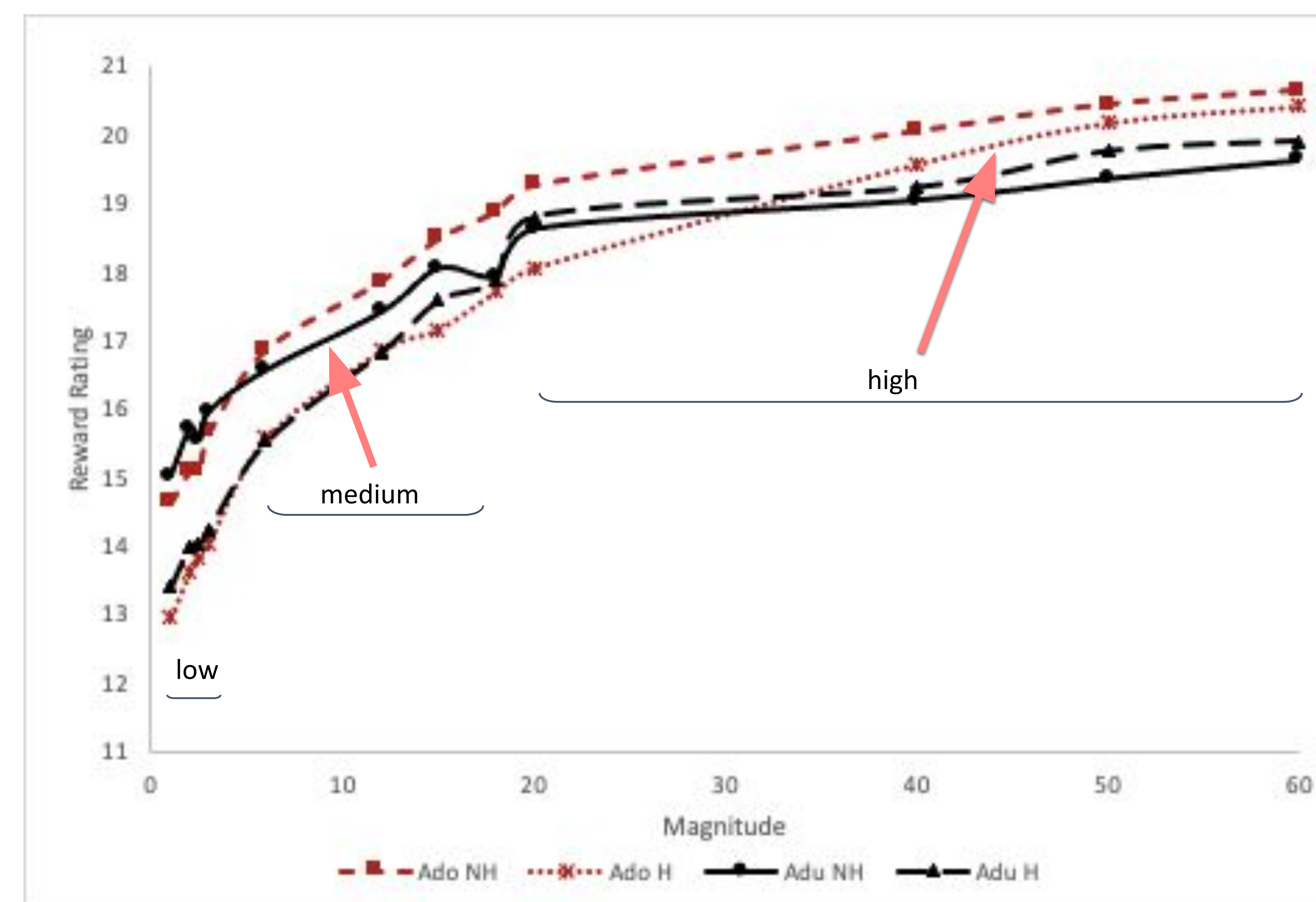
Mean Reward Ratings by Age and Hunger Group

Figure 2. Mean reward rating for each magnitude (4 levels per magnitude) separated by age and hunger group. NH = Non-hungry and H = Hungry, Ado = Adolescents and Adu = Adults. Error bars represent +/- 1 SE.

Summary and Discussion

Based on difference scores, age and hunger interacted with reward magnitude of reward such that:

- Non-hungry adults were the least motivated group – they did not differ in the extent to which they differentiated levels of low, medium, or high magnitude rewards. As illustrated by Figure 2, this group exhibited the shallowest slope with respect to increasing levels of medium magnitude rewards.
- Hungry adults and non-hungry adolescents were in the middle with respect to motivation – they differentiated more between medium sized rewards compared to smaller rewards, but they differentiated less between larger rewards compared to medium rewards.
- Hungry adolescents were the most motivated group – they did not exhibit decreasing differentiation between medium and high rewards. Instead, as illustrated by raw reward ratings (Figure 2), hungry adolescents exhibited the steepest slope with respect to increasing levels of high magnitude rewards.

This pattern of results demonstrates that age and hunger both matter with respect to reward sensitivity, as measured through difference scores.

Abstract

Reward valuation generally reflects negative acceleration as magnitude increases; how age and hunger modulate effect this is less understood. Subjects (69 adolescents, 63 adults) rated monetary low, medium, and high rewards on liking/wanting, half while hungry. High minus low valuation was calculated for each magnitude. Difference scores did not vary for non-hungry adults across magnitudes. Hungry adults resembled non-hungry adolescents, exhibiting negative acceleration (non-monotonic pattern). Hungry adolescents, with the highest hypothesized reward motivation, exhibited a monotonic pattern of increasing differentiation across magnitude, showing how age and drive both matter in valuing rewards.

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