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The Design, Development, and Implementation of a Coding System for a "Hot" Self-Regulation Task

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THE DESIGN, DEVELOPMENT, AND IMPLEMENTATION OF A CODING SYSTEM FOR A HOT SELF-REGULATION TASK

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By

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ABSTRACT

Effortful control is one component of self-regulation that consists of the ability to delay a dominant response in favor of a non-dominant response. One way to measure effortful control is through “Hot” self-regulation tasks, which are when a participant is asked to delay a dominant response when there is a reward or punishment associated with the task. There are two types of “Hot” self-regulation tasks: affective decision making and delay of gratification. One way to assess of delay of gratification abilities is through an experimental task known as Snack Delay, where participants (usually children) are shown a snack but are asked to wait to eat it. If they are able to delay their dominant response and wait, they are rewarded with either a preferred snack or more snacks. The current study sought to create a more refined measure of delayed gratification by modifying the original coding system to be a more complex and sensitive measure in an attempt to capture a wider range of self-regulation abilities. It was shown that this new coding scale could be accurately and reliably used when coding. This current study also examined differences in delay of gratification abilities between 3-year-olds and 4-year-olds, which produced no significant differences.

Keywords: Self-Regulation, Effortful Control, Delay of Gratification, Snack Delay

I dedicate my thesis to my parents, Susan and Steve Martin, who have constantly inspired me to be the best version of myself. I also would like to thank Dr. Elizabeth Lemerise as well as Jasmine Ernst for their support and help.

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INTRODUCTION

Self-regulation is an important developmental milestone that is defined by the ability to control emotions and behavior to act in a way that maximizes the advantages of a context or circumstance (Blair & Ursache, 2011). One type of self-regulation is effortful control which consists of the ability to intentionally delay, change, or suppress a dominant response (Kochanska et al., 2000). Examples of effortful control in everyday life are paying attention when there are distractors or stopping an impulse that is not conducive to the current environment. People who exhibit high levels of effortful control can voluntarily control their actions, emotions, and attention in a variety of contexts.

There are many variables that have been shown to share associations with high levels of effortful control, the first of which is an ability for focused attention (Kochanska et al., 2000). Additionally, individual experience has been shown to influence capacity for effortful control, with responsive parental relationships, secure attachments, parental socialization, and self-control also sharing positive influence (Kochanska et al., 2000). One of the most salient predictors of effortful control is affective synchrony between mother and child (Blair, 2002), which is the coordination of expression during face-to-face interactions that allows for infants to practice interpersonal coordination and build structures of adult communication (Feldman & Greenbaum, 1999).

Effortful control is important to healthy development as it shares relations with socioemotional growth, lower risk for psychopathology, and better academic performance (Allan & Lonigan, 2011). In terms of academic performance, research has shown that academic success has many influences beyond cognitive abilities, and that the most important predictor of academic performance in children entering kindergarten was their self-regulation and effortful control skills (Blair, 2002). It has been shown that promoting emotion-related skills can promote academic competence in the future (Izard, 2002 cited in Valiente et al., 2007).

Effortful control first emerges in children between 6 to 12 months of age, and it can be measured significantly in children after 2.5 years of age (Allan & Lonigan, 2011). One way to measure effortful control is through tasks known as "hot" self-regulation tasks. "Hot" self-regulation tasks have been characterized as those in which participants are asked to regulate emotion when there is a reward or punishment associated with the task (Allan & Lonigan, 2011). This type of self-regulation is associated largely with the orbitofrontal cortex and limbic system; damage to either of these areas is likely to result in poor performance on "hot" self-regulation tasks, inappropriate emotional behavior, and trouble with social interaction (Carlson, 2005). "Hot" self-regulation typically comes in two forms: affective decision making or delay of gratification.

Affective decision making refers to a situation in which a risky choice must be made that involves an interaction between "rational" processes and "emotional" processes (Bracha & Brown, 2012). One example of this type of affective decision making is the Children's Gambling Task (Kerr & Zelazo, 2004). In this task, children were to choose a card from two decks, and the card would either have a happy face that was associated with a candy reward, or a sad face that had no reward. In deck 1, there were more rewards available, but this was considered a "disadvantageous" deck because there were occasional large losses. On the contrary, deck 2 offered fewer rewards, but also had fewer losses, making this the "advantageous" deck. It was reported that 4-year-olds made more "advantageous" decisions than 3-year-olds in this task, showing that affective-decision making has large developments during the preschool period.

Delay of gratification involves a task that necessitates the resistance of short-term temptation for long term goals (Koomen et al., 2020). Some well-known "Hot" self-regulation tasks that require delay of gratification are Gift Delay (Kochanska et al., 1996) and Snack Delay (Mischel & Ebbesen, 1970). In both of these tasks, successful performance requires the use of behavioral inhibition to resist the impulse to either touch an enticing gift or eat a treat. In the Gift Delay task, 30-month-olds sat at a table when an experimenter placed a colorful gift bag on the table in front of the child. Then, the experimenter told the child not to touch the bag now, but to wait until the researcher returned with a bow for the present. The experimenter then left the room for 3 minutes.

Behavioral inhibition was coded on a 5-point scale; a 1 was given if the child took the gift from the bag, a 2 was given if the child put his/her hand into the bag, a 3 was given if the child peeked into the bag, a 4 was given if the child touched the bag without peeking in, and a 5 was given if the child never touched nor peeked into the bag. Performance on this task was correlated positively with adult reports of behavioral control (Kochanska et al., 1996). In addition, results were related closely to scores on another delay of gratification task, Snack Delay.

"Snack Delay" is a type of experimental task in which a participant, usually a child, is shown a desirable snack, but if they are able to resist eating it (behavioral inhibition), they will receive a more desirable reward (e.g., preferred snack or more snacks). This snack delay task was first developed in the 1970s by Stanford University's Walter Mischel (Mischel & Ebbesen, 1970). In this task, children ages 3-to-5-years old were asked to choose their preference between two snacks, pretzels or animal cookies. Whichever snack they chose became their "desired" reward whereas the other became their "undesired" reward. The child was then told that the experimenter would leave the room, and if they waited for the experimenter to return, then they could eat their "desired" snack. But, if they could not wait for the experimenter to re-enter the room, they could eat a small "signal" snack, and the experimenter would come back immediately. It was explained to the child that if they summoned the experimenter by eating the "signal" snack, they would be given the "undesired" snack upon the experimenter's return. The child therefore faced a dilemma between waiting for a more rewarding snack or eating the less rewarding snack immediately.

Children were randomly assigned to one of four groups; either they sat with both rewards in front of them, the "desired" reward only, the "undesired" reward only, or no rewards. The results were coded based on how much time children waited to eat the "undesired" reward or waited for the experimenter to return. Children waited the longest when neither reward was present, and the shortest when both rewards were present (Mischel & Ebbesen, 1970). These results showed that when a snack is present, behavioral inhibition is difficult.

This experiment has since been replicated many times. For example, Mischel et al. (1972) further examined how cognitive factors could influence delayed gratification. Fifty 3-to-5-year-olds were asked for their preferences between a pretzel or a marshmallow. The children were then left alone with the option to wait until the experimenter came back, in which case they would receive their preferred snack, or they could ring a bell to have the experimenter return early, in which case they would receive their not-preferred snack. In all trials, the two snacks were physically available to the child. The children were placed randomly in three groups while they waited for the experimenter to return: a control group of no distraction, a cognitive strategy group to inhibit behavior through internal distraction (thinking about something fun), or a behavioral strategy group to inhibit behavior through an external distraction (playing with a toy. Results of this study were coded based on the amount of time that the children either rang the bell or waited for the experimenter to return. This experiment found that children were the most likely to delay gratification if they were internally distracted by thinking about experimenter-presented questions (Mischel et al., 1972).

In another similar study by Kochanska et al. (2000), an M&M was placed under a transparent cup in reaching distance of a child. Child participants at 22 and 33 months old were to keep their hands on a mat on the table and wait until an experimenter rang a bell to lift their hands and retrieve the snack. There were four trials total, with delays that ranged from 10-30 seconds (Kochanska et al., 2000). The coding of Kochanska et al.'s (2000) task used "points" given to the child based on his/her ability to wait to touch the snack. The child was given 1 point if he/she touched the candy before the experimenter rang the bell to begin the trial, 4 points if they touched the candy once the trial began, and 7 points if they waited until the experimenter rang the bell to signify the end of the trial. This Snack Delay task was a significant predictor of social development and socialization levels, including better regulated anger and joy.

This Snack Delay task was later included in the Preschool Self-Regulation Assessment (PSRA). The PSRA is a battery of 10 tasks that was developed to create a comprehensive test of the three domains of self-regulation in preschoolers ages 3-to-5-years: emotion, attention, and behavior (Smith-Donald et al., 2007). Snack Delay was one of four tasks included as a measure of effortful control in this battery. Children who had high performance on the 10 tasks included in the PSRA were more likely to be reported as being better emotionally regulated and more socially competent while being less impulsive, disobedient, and anxious (Smith-Donald et al., 2007).

The ability to delay gratification has been shown to be largely associated with environmental contexts. One of the greatest predictors of delay of gratification performance is socioeconomic status, with impoverished children tending to have the lowest performance (Raver et al., 2011). One reason for this is the ongoing belief that humans adapt behavior in order to make the current environment to meet their goals, and goals are dependent on context. Children from higher socioeconomic status environments may be more likely to delay gratification on resource-related tasks than children from lower socioeconomic status environments because they have different goals. In an environment where access to a resource (i.e. food) is uncertain, it is actually adaptive for children to resist delaying gratification (Sturge-Apple, 2016).

Extensive research has been conducted on the positive correlates of high performance on delay of gratification tasks in preschool-age children. Results in these studies show that children with better performance, or who are able to wait longer periods of time, were later shown to have a better overall well-being (Mischel et al., 2011). These results held stable over their lifespan. Moreover, high scores on inhibitory control measures were predictors of better performance in math (Epsy et al, 2004), literacy and vocabulary (McClelland et al., 2007), and social skills (Brophy-Herb et al., 2019). In addition, the ability to control impulses has been shown to be related negatively to adjustment problems later in life (Olsen et.al. 2002).

Although it is beneficial to understand that measures of effortful control are predictors of positive life outcomes over a lifetime, there are gaps in research on how performance on these measures actually changes throughout preschool. It has been theorized that because the cognitive and developmental differences between children who are 3-to-5-years old are so substantial, it is necessary to view them in individual categories instead of one category of “preschoolers” (Ackerman & Friedman-Krauss, 2017). Thompson et al.’s (1997) experiment on preschoolers’ ability to delay gratification for stickers found that 4-year-olds were significantly more likely to wait for a larger reward than 3-year-olds. In addition, four-year-olds have been shown to out-perform three-year-olds on the PSRA measures of “hot” self-regulation (Bassett et al., 2012).

Alternatively, when looking at whether the same growth in delay of gratification abilities over the preschool period is true for children of a lower socioeconomic status, it was shown that this trend was not the case (Fugate, 2019). This study administered a modified version of the Snack Delay task that is included in the PSRA to children in a Head Start program. Head Start is a national program that provides preschool access to children of a lower socioeconomic status. In order to test for differences between preschool age children, Fugate’s (2019) study needed to allow for increased difficulty to ensure that no participants were at ceiling for the task. Therefore, the number of trials was increased from 4 to 10. In addition, the longest duration of trial was increased from

30 seconds to 180 seconds. The results were live coded using the scale included in the PSRA: 1 point if the child ate the snack, 2 points if they touched the snack, 3 points if they touched an experimenter’s material, and 4 points if they did not touch a material or the snack (Smith-Donald et al., 2007). This study showed no significant effects of age on performance (Fugate, 2019).

Current Study

The current study aimed to take the results of the previous study (Fugate, 2019) and determine if age differences did exist when they were analyzed with a more refined and sophisticated measurement scale. It was hypothesized that one reason for the lack of significant findings was that the task was coded with the simple coding scale used in the PSRA (1 point if the child ate the snack, 2 points if they touched the snack, 3 points if they touched an experimenter’s material, and 4 points if they did not touch a material or the snack) (Smith-Donald et al., 2007). This current study implemented a more complex 8-point-scale would more allow for a more sensitive measure of behavioral inhibition during the Snack Delay Task than the 4-point scale used in the previous study. The first research question was whether or not the new, more complex 8-point scale could be coded reliably among researchers. It was predicted that the researchers would be able to achieve above 80% inter-observer agreement when using the new coding scale.

This study also was designed to answer the question of whether there were significant differences in performance on Snack Delay behavioral inhibition task between 3-to-5-year-olds when using the new coding scale. Because of previous research on the increased ability to delay gratification in preschool years, it was predicted that there would be age effects on performance with 5-year-olds would have the highest performance, and 3-year-olds would have the lowest.

METHODS

Participants

Participants in this study were 77 preschool children including 27 three-year-old children (15 boys and 12 girls) and 41 four-year-old children (25 boys and 16 girls), and 9 five-year old-children. All of the participants were attending Head Start preschool programs in Bowling Green, Kentucky. Sixty participants were attending the WKU Child Care Center which is a blended child care/Head Start program and 17 were from the Warren County Head Start program. Each child received parental consent to participate, and each child’s assent was obtained prior to the beginning of the experiment.

Materials and Equipment

Materials needed for the Snack Delay task were two different snacks, Goldfish crackers and M&Ms. There were also two transparent cups, one that faced up and one that faced down, that were placed on one paper plate. The researcher had a timer that beeped so that the child was given an auditory signal of when to reach for the snack. Trials were recorded with a camera (brand: Sony; model number: DCR-SR100).

Procedure

In this modified version of the Snack Delay Test, the child sat at a table across from one main researcher, while an assistant researcher sat about 6 feet away and recorded the trial on camera. In reaching distance of the child were two transparent cups placed on a plate, one facing up and one facing down. In order to increase the difficulty of the Snack Delay task as a measure of effortful control, the number of trials was increased from 4 to 11. The first trial was a practice that began by letting the child choose between their preference of Goldfish Crackers or M&Ms. The child was allowed to try the snack, and once done, was given the following instructions:

> "Ok, for this game keep your hands here, flat on the table. I will hide a Goldfish/M&M under this cup, when I beep the timer and say 'Time" you can get the goldfish/M&M and put it in this cup for later".

The researcher then set a timer for 10 seconds, placed the preferred snack under the cup that was facing down, and then began the timer. If the child reached for the snack, the child was instructed to wait until the timer beeped. After the timer beeped, the child was instructed to place it in the other cup that was facing up. This was then followed by 10 subsequent trials that were the following time intervals: 20-, 40-, 10-, 60-, 20-, 90-, 10-, 120, 15-, and 180- seconds. Each trial began with the researcher saying the following:

"Ok, that's how you play. We're going to do it again. Keep your hands flat on the table. Remember to wait until I beep the timer and say 'Time" before you look for the M&M/Goldfish."

Each trial was coded by both the main and assistant researcher on a four-point scale as in the PSRA (Smith-Donald et al., 2007): 1- eats snack, 2- touches snack, 3- touches cup/timer, 4- waits for the timer to beep (does not touch cup or timer). In this task, "failing" (coded 1) was determined by eating a snack at any time during the task (before, during, or after the trial). Trials 1-4 were completed no matter what, but if the participant ate the snack at any time during these trials, the task was stopped after the 4th

trial. If a child did not reach "failure" during the first 4 trials, they continued with the remaining trials but stopped if they ever reached "failure" before completing all 11 trials.

Coding

Although the 4-point coding system used in the PSRA (1: eats snack, 2: touches snack, 3: touches material, 4: doesn't touch snack or material) was used while the trial was taking place (Smith-Donald et al., 2007), each trial was later re-coded by watching the video that was taken of each participant. Trials were re-coded in order to use the more refined and detailed coding system that was developed to capture the full range of behaviors participants engaged in during the study. This more refined coding system was developed from the coding system used in the PSRA but was adapted by researchers to include more specific behaviors. In this coding system, a "material" referred to any object involved in the task administration, including but not limited to: cup, plate, timer, snack bag, test battery/coding guide, the researcher's pencil, or the researcher's items. "Touching" referred to any form of bodily contact, including with hands, arms, forehead, elbow, or any other body part. Each trial was coded using the following system:

Eats Snack (1) was given if a child ate a snack, either currently under the cup or from a previous trial, at any time during the administration of the Snack Delay task.

Touches Snack (2) was given if the child touched the snack under the cup, or any of the other accumulated snacks, during a given trial.

Picks up and plays with materials (3) was given if the child had more than one instance of picking up and putting down any of the task materials during the trial, or if any of the materials were lifted for more than 4 seconds without being put down.

Picks up materials briefly (4) was given if there was one instance of the child lifting the material from its surface (including tilting), but it was not lifted for more than 4 seconds.

Hands not flat, long touch on materials (5) was given when a child touched an item for longer than 2 seconds or slid it across the surface without lifting it from the table.

Hands not flat, brief touch on materials (6) was given when a child touched any one of the materials once or multiple times, but each individual touch did not last more than 2 seconds.

Hands not flat, no touch on materials (7) was given if the child did not keep their hands flat including if their finger or palm was lifted, but they did not touch a material.

Hands flat, no touching of materials (8) was given when the child kept their hands flat on the table for the entire trial, even if they slid their hands without lifting any part of their hand, but not including if their hands were flat while they touched any of the materials.

Reliability

In order to ensure reliability between researchers on the new 8-point coding scale, the two researchers involved with coding were randomly assigned a set of 5 participants and were asked to individually watch the same video of the Snack Delay trial and code them. All disparities between these coding assignments were re-assessed together. They were both then assigned 5 more random participants, and the same procedure was repeated until the coders reached 80% agreement between their individual coding scores.

RESULTS

Reliability

After reaching the 80% agreement criterion, reliability among researchers was conducted on an additional 10 out of 77 participants (12.98%). The level of reliability was analyzed by using a Cohen's Kappa which corrects percent agreement for chance agreement Researchers coded reliably with the new coding model ($K = .863$, $p < .0001$).

Age Effects on Performance

The second goal was to determine if there were significant differences in performance among 3-year-olds, 4-year-olds, and 5-year-olds. First, descriptive statistics were obtained to examine the average performance per trial of all participants (Table 1). Data from the practice trial were excluded from the analysis because the goal of the practice trial was to teach the participants how the task worked.

Table 1: Average Performance Per Trial

Trial	Seconds	Mean	Std. Deviation	Min. Score	Max Score
1	20	5.87	2.34	1	8
2	40	6.04	2.03	1	8
3	10	6.47	1.99	1	8
4	60	5.92	2.08	1	8
5	20	6.56	1.36	2	8
6	90	6.02	1.67	1	8
7	10	6.54	1.50	2	8
8	120	5.85	1.64	1	8
9	15	6.29	1.72	2	8

10	150	5.50	1.81	2	7

Then, average performance score across trial by age in year was calculated (Table 2).

Table 2

Average Performance Across Trials by Age in Years

Age in Years	Mean	Std. Deviation	N
3	5.7130	1.65840	27
4	5.9634	1.80506	41
5	5.8000	1.49164	9
Total	5.8565	1.70407	77

Then, a one-way analysis of variance was run to determine whether there were significant differences in performance based on age in years. Results of this analysis showed no significant effect of age in years on average score, F (2, 74) = .0177, p = .838, partial eta^2 = .0005.

Next, a correlation was run to determine if a significant relationship existed between performance and age when age was categorized by months. This was to determine whether age and performance shared an ongoing relationship instead of viewing age solely in terms of years. Results of this test concluded that age in months did not hold a significant relationship with performance (r = .078, n = 77, p = .499).

DISCUSSION

Reliability

Reliability is important because studying social sciences necessitates the measurement of human behavior. One challenge in doing so is creating repeatability, or having many researchers replicate the same findings. Testing reliability is one way to ensure that results can be repeated, and therefore are more likely to be trustworthy (Drost, 2011). Inter-rater reliability is one common way to measure reliability by judging the internal consistency of multiple judgers or coders (Drost, 2011). The higher the interrater agreement, then the higher that the reliability of the coding system is because it shows that there are high levels of agreement among different researchers.

Results of this study supported the hypothesis that the modified 8-point coding scale could be implemented reliably among researchers because multiple researchers were able to reach 86.3% inter-rater agreement. The limitation to this measure of interrater agreement were the limited number of participants who were coded by both researchers (12.98%), and future studies should include reliability trials on a greater number of participants to ensure a better estimate of reliability.

Age Effects on Performance

Results of this study did not support the hypothesis that there would be significant age differences in performance on the Snack Delay task when using the more refined 8-point scale. The hypothesis was that as age increased, performance would be greater. However, after analyzing performance by age in years and age in months, there were no significant differences.

One explanation for why the data from the current study are did not support previous studies that found age differences in delay of gratification tasks among preschoolers was the lower socioeconomic status of the participants. This sample was comprised of children in a Head Start program, which exclusively serves low-income children and families. Previous studies have shown lower performance on delay of gratification in students from more impoverished backgrounds and have hypothesized that it is because not delaying gratification can actually be an adaptive behavior when a child is from a low-resource environment (Sturge-Apple, 2016). This study supports that research by showing that the average score per trial across all preschool age groups was between a 5-6, showing that delaying gratification was relatively hard for many of the participants. A reasonable explanation for this is because accessing resources like food is more important than delaying gratification in children of a lower socioeconomic status, while not having as large an effect on children from a higher-resource environment. Future studies should compare the performance of children from varied economic statuses to determine whether if the reward were altered (i.e. a toy, a sticker), would there be significant age differences among preschoolers in their ability to delay gratification.

In addition, it could have been a more effective measure of the dependent variable to include data on performance by time of trials rather than just an average across all scores. The differences in times (ranging from 10 seconds to 150 seconds) provided a large opportunity for variability among trials that was not accounted for by averaging all of the trials together. For example, there might have been age differences among some of the longer trials, but not among the shorter trials. Future studies should determine if there are significant age differences among each specific timed trial to account for the wide range of wait times.

Another approach would be to examine the number of trials completed by age group. In this study, when the child "failed" by eating the snack, all remaining trials were not completed as long as they had finished the first 4 required trials. Another way to examine performance could have been to use how many trials were completed as a variable rather than just their scores on those trials. This would have been helpful, because it could have shown whether age played a role in the patience a child had to get through all of the trials. It can be inferred that it would be easier to delay gratification at the beginning of the game, but more difficult as the child completed more trials and repeated the same steps. Seeing how many trials that the child actually completed without eating the snack would have given insight into a different aspect of performance that may be related to age differences.

Lastly, this study only examined the behavioral inhibition aspect of effortful control. In order to fully account for each participant's ability to use effortful control, it would be necessary to also have measures of attention shifting and emotion regulation. Future studies should use coding systems to measure the participants' attention and their emotion regulation (i.e. expression) to create a complete measure of effortful control.

Although this study created a more refined and sophisticated 8-point coding system to measure behavior during the administration of a Snack Delay task, the results did not produce any differences than when the PSRA 4 point-scale was used. Future studies should continue using the 4-point scale as a measurement of delay of gratification. This study also highlighted previous findings that when it comes to the ability to delay gratification, context matters. Although children from upper- and middle-class backgrounds have been shown to increase their ability to delay gratification during the preschool period, the same cannot be said for children from lower socioeconomic backgrounds. This is important to know, because delaying gratification as a component of effortful control is a predictor of many positive life outcomes. Being raised in a low-resource environment can make it more challenging for these children than others, and automatically makes them more at-risk than their peers. This study is important because it highlights the ongoing need for intentional support of the self-regulation abilities of students in lower socioeconomic statuses. Children from different backgrounds have different realities, and in order to ensure that preschoolers of a lower socioeconomic status are equally ready for kindergarten, they need access to learning and practicing self-regulation during preschool.

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