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A preference for delayed rewards in children: developmental effects and individual differences

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A Preference for Delayed Rewards in Children: Developmental Effects and Individual Differences

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Summary

Self-control has traditionally been defined as a choice between a larger, delayed reward over a smaller, immediate reward (Ainslie, 1974; Rachlin and Green, 1974). The current studies utilised a discrete trial paradigm to determine if young children are sensitive to amount and delay, if there are developmental changes in children's preference for delayed rewards, and if children's choices on a delay task are related to direct measures of their behaviour.

In Study 1, children between the ages of 3- and 5-years-old were presented with a computer task and asked to chose between 1 sticker after 5s, or 3 stickers after delays of 5- to- 200s. All of the children chose the larger reward less often as the delay increased.

Study 2 tested for developmental effects in children's preference for delayed rewards. Children ages 4-, 6-, and 8-years-old chose to receive 1 reward after 2s, or 3 rewards after delays of 30-, 60-, or 120s. Data were collected for 30 minutes on their attention and activity levels in the classroom. All 3 groups of children chose the larger reward less often as the delays increased. The 8-year-olds chose the larger reward more often than the younger children at all levels of delay. Their choices on the computer task did not correlate with the measures of classroom behaviour.

In Study 3, a group of hyperactive children and matched controls chose to receive 1 reward after a 2s delay, or 3 rewards after a 60s delay. Classroom data were collected for 3 mornings using the same measures as in Study 2. The

hyperactive children made more choices of the smaller, immediate rewards than their peers on the computer task and these choices correlated with their activity levels in the classroom.

It was concluded that children are sensitive to the amount and delay of reinforcement, and that there are both developmental effects and individual differences in children's preference for delayed rewards.

Table of Contents

Chapter 7: Study 3

Chapter 8: Conclusion

List of Tables and Figures

Chapter 5

Chapter 6

Chapter 7

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Chapter 1: Theories of Self-Control

The study of self-control and impulsivity can be dated back to Aristotle, who defined *akraisa* as a weakness of will. Akraisa occurred when individuals were ruled by passion rather than reason. Freud later distinguished between the reality principle which serves long range goals, and the pleasure principle, which serves short term goals. (Ainslie, 2001)

Modern day psychologists have defined self-control as any choice that results in higher value rewards that are available after a delay over lower value rewards available immediately. Actions and choices that result in the lower value rewards are considered impulsive (Logue 1995). When given a choice between a reward available after a delay, and an identical reward available immediately, most people and animals prefer the immediate reward. (Ainslie, 1974, Logue, 1988, Rachlin and Green, 1972, Rachlin, 1989). When the choice is between a lesser value reward available immediately or a larger reward available after a delay, people's behaviour is less predictable. They are said to exhibit self-control when they choose the larger, delayed option over the smaller immediate option.

We are faced with such dilemmas every day. A student who chooses to stay in and revise rather than going to a party is making a self-

controlled choice. The rewards of high marks will not be enjoyed for at least a few weeks, and the pleasure of the party will be immediate. Putting money in a savings account rather than spending it is a self-controlled choice, as the person forgoes the immediate pleasure of spending the money in lieu of the long term benefit of saving.

Self-control also occurs when people engage in an unpleasant task to avoid even greater discomfort. Going to the dentist regularly may be unpleasant, but it can prevent painful toothaches and even more painful dental work (Rachlin, 1988). To avoid going to the dentist is impulsive, the immediate reward is avoidance of the dentist, but the longer term consequences of tooth aches will be more punishing. Enduring aversive stimuli in order to receive a high valued reward is considered self-control (Kanfer and Goldfoot, 1966); cleaning the house may be unpleasant, but the reward of having a clean house makes the task worthwhile. Engaging in repetitive tasks in the face of distractions (Patterson and Mischel, 1975) and completing hard work in order to obtain a desired outcome are both considered self-control (Eisenberger, 1992). All of these examples involve postponing immediate gratification in favour of a higher value, long term reward.

Evolutionary psychologists argue that people have evolved to make impulsive choices (Logue, 1995; Samuelson, 1976). Humans may once have foraged for food and could not rely on the availability of food in the future. A person had the best chances of survival if they ate large portions when food was available, because postponing eating until later might result in starvation. Furthermore, if humans suffered from high

mortality rates there was little justification for postponing sexual activity and childbearing. If a person could not count on being alive in a year, they were most successful by reproducing early and frequently. Not eating too much now, or postponing sexual activity could result in starvation or a failure to pass down one's genes.

In the modern, Western, world many humans have a constant and predictable supply of food. Modern medicine has extended the human life span, and people can plan to live long, healthy lives. In this scenario, acting impulsively will minimize a person's overall rewards. If a modern person eats all the food available to him, every time it is available, he will be come obese and compromise his health. Modern day children are encouraged to abstain from childbearing until they have the emotional maturity and financial resources to provide for a family. In the modern world, the total amount of reinforcement can often be obtained by exhibiting self-control. To eat moderately means that one live a long, healthy life, to do otherwise is impulsive.

The study of self-control is important to understanding mental illness. Strayhorne (2002) argues that a deficiency of self-control is a core feature of many psychopathologies. A failure of self-control results in patients not considering the consequences of their actions. People with addictions often choose the immediate pleasure of drugs, gambling, or alcohol over their long term goals and happiness. They have trouble maintaining relationships and keeping jobs, and they often jeopardise their own health. Obese people often choose the immediate pleasure of food over the longer term benefit of good health. Overweight children are

less able to delay gratification for food than their peers (Bonato and Boland, 1983), and people who suffer from bulimia impulsively binge eat (Lacey, 1993).

The study of self-control and impulsivity is important as it can help scientists understand how people make decisions that maximise the amount of reinforcement they obtain from the environment and may contribute to an understanding of psychopathology.

Different Approaches to the Study of Self-Control

Self-control has been studied from many different perspectives. Behavioural psychologists define self-control as a preference for larger, delayed rewards over smaller, immediate rewards (Rachlin, 1989). Economic theorists have studied self-control as the discounting of delayed rewards; they are interested in when waiting for a larger reward is no longer worthwhile (Myerson and Green, 1995). Personality theorists have studied self-control under the name self-regulation, or delay of gratification. They are interested in what personality traits are linked to self-control. The current chapter will review these approaches and summarise the major findings in each field.

Behavioural Approach

The study of self-control from a behavioural perspective is a considered a subset of literature on the matching law. Herrnstien's (1961,

1970) matching law predicts that the relative rate an individual engages in any behaviour is equal to the relative rate of reinforcement of the behaviour. The strict matching law states:

$$\frac{B_1}{B_1 + B_2} = \frac{R_1}{R_1 + R_2}$$

where B refers to the behaviour frequency and R refers to the amount or reinforcers received. The relative rate of a behaviour is equal to the relative rate of reinforcement derived from that behaviour (Davison and McCarthy 1989, Herrnstein 1997.)

The matching law states that if we could determine the value of all the reinforcers in the environment, we could predict behaviour. Of course, this is impossible, we can never know the value of every reinforcer for a person at each moment in time. We do know some of the variables that determine a reinforcer's value. These are the rate, quality, and amount, of the reinforcer, the delay to receiving reinforcement, and the effort required to obtain the reinforcement (Baum 1979). This can be expressed as:

$$\frac{\text{Behaviour}_1}{\text{Behaviour}_2} = \frac{\text{Rate1}}{\text{Rate}_2} \cdot \frac{\text{Amount}_1}{\text{Amount}_2} \cdot \frac{\text{Quality}_1}{\text{Quality}_2} \cdot \frac{\text{Delay}_1}{\text{Delay}_2} \cdot \frac{\text{Effort}_1}{\text{Effort}_2} \cdot = \frac{\text{Value}_1}{\text{Value}_2}$$

According to the generalised matching law, increasing the rate, amount, and quality of a positive reinforcer increases its value. Decreasing the amount of effort required to obtain the reward and lessening the delay

to receiving a positive reinforcer also increases its value. The behavioural frequency is equal to the total value of the reinforcement.

Self-control is a subset of choice behaviour that occurs when a subject chooses a higher quality or amount of a reinforcer after a delay, over a lesser reinforcer immediately. Impulsivity is defined as a choice of the smaller, immediate reward (Ainslie, 1974; Rachlin and Green, 1974).

Self-control has traditionally been studied in the laboratory using a discrete-trial methodology. In a typical behavioural laboratory experiment, participants are asked to choose between a small amount of a reward available immediately or a larger amount of the reward available after a delay. The rewards tend to be small, either a small amount of food or points exchangeable for money at the end of the session. The most common paradigm is a discrete trial procedure with a fixed number of trials per session. The duration of each trial is constant; if the trial lasts one minute, participants might receive a small amount of a reward after 20s, and wait 40s for the start of the next trial. Or they may receive a larger amount of the reward after 40s and wait 20s for the start of the next trial.

Most non-human animals choose impulsively when given a choice between a small amount of food available immediately or a larger amount available after a delay. Rachlin and Green (1972) presented pigeons with a choice to peck a red key and obtain 2 seconds of access to food followed by 6 seconds when the experimental chamber went dark, or peck a green key and receive 4 seconds of blackout followed by 4 seconds of access to food. When presented with this choice, the pigeons developed an

preference for the immediate reward over 95% of the time, even though this meant they received less reinforcement across the entire session. This finding has been widely replicated (Ainslie, 1974; Ainslie and Herrnstein, 1981; Mazur and Logue, 1978; Navarick and Fantino, 1976).

Animals have a preference for smaller, immediate rewards unless they have had training or there are commitment strategies in place. Rachlin and Green (1972) presented pigeons with 2 the following scenarios: a) first they peck an initial link and they have access to two new keys: a left and a right key; b) if they peck the right key, the chamber darkened and they then had access to a red associated with a larger, later reward and a green key associated with a smaller, immediate reward. When presented with this option the pigeons almost always chose to receive a small amount of food right away; c) if they chose the left key after the initial link, the chamber went dark for a few seconds, and then only the larger, delayed option was available to the pigeon.

When they chose the right link and were given a choice of two keys, the pigeons almost always chose the smaller, less delayed option. By choosing the left key, the pigeons committed themselves to waiting for the larger, delayed reward. All of the pigeons initially preferred the left key, but their preference shifted to the right key after several sessions. By committing to the delayed reward, the pigeons were ensuring that they maximised the total amount of the reward they received during a session.

Mazur and Logue (1978) presented a control group and an experimental group of pigeons with a choice of a large or small food reward. The pigeons experienced 31 choice trials, during which both

choices were available, and 3 no-choice trials when they could only choose the smaller food alternatives. The control group chose between 2 seconds of access to food available that was immediately or 6 seconds of access to food available after a 6 second delay; these pigeons almost always chose the small, immediate reinforcer. The experimental group initially chose between 2s or 6s of food access both available after a 6s delay. In this condition, they almost always chose the larger reward. Over the course of a year, the delay to the smaller reinforcer was reduced to zero seconds. After the training, some pigeons in the experimental group continued to select the larger reward more often than the control group when there was no delay to the smaller reinforcer. Mazur and Logue (1978) suggest that the pigeons in the experimental group were trained to prefer the larger, delayed reward.

These studies (Mazur and Logue, 1978; Rachlin and Green, 1972) suggest that pigeons can be taught to make choices of larger, delayed rewards over smaller, immediate rewards. However, the pigeon's preference is for smaller, immediate rewards when extensive training or pre-commitment procedures have not been implemented. Using similar paradigms, very different results have been found with adult humans.

Studies using positive reinforcement have failed to find impulsivity in adult subjects using the discrete-trial paradigm. Millar and Navarick (1984) gave college students a choice between playing a video game for 40 seconds after a delay of 120 seconds, or playing a video game for 10 seconds after no delay, with a 150s wait until the next trial. Adults in this study did not show a significant preference for either option. In control

conditions the amount of play time or the length of delay was held constant subjects preferred longer playing times and shorter delays. The authors argued that although subjects did not show a preference for the smaller, sooner (SS) option in experimental condition they still chose a shorter game more often than they did in the control conditions. Even if subjects did sometimes choose impulsively, it may be more accurate to conclude that they were indifferent.

Navarick (1986) presented adults with photographs of celebrities, and varied the duration of time the photographs were in view. As in the video game study, subjects preferred to look at the images for longer when delay was held constant, and preferred to view them immediately when duration was held constant. When given a choice between 10 seconds of viewing followed by 70 seconds of waiting, or 40 seconds of waiting followed by 40 seconds of viewing, subjects were ambivalent in the last quarter of the session. Navarick argued that this is evidence of impulsivity, because the participants did not make self-controlled choices during all of the trials. In a longer task, subjects preferred 80 seconds of waiting followed by 40 seconds of viewing to 10 seconds of viewing followed by 110 seconds of waiting, this time showing self-control.

An analysis of Navarick's data reveal that although subjects made some impulsive choices, they never showed a significant preference for a smaller, sooner reward over a larger, later reward when the inter trial interval was held constant. A more reasonable claim may be that subjects were indifferent between the two options. To argue that they acted impulsively is too a broad claim based on the data.

It also unclear from Navarick's studies if the photographs and video games were positive reinforcers, or if the time with no stimulation was an aversive stimulus. It is possible that the subjects were not as eager to see the photograph, as they were to minimise the amount of time with no stimulation. A combination of different reinforcement processes might have produced the rather ambiguous data found in these studies.

Logue, Pena-Correal, Rodriguez, and Kables (1986) presented subjects with the opportunity to earn points that were exchangeable for money at the end of the session. This study differs from the previous three in that Logue et al. used a secondary reinforcer that needed to be saved until the end of the session. The previous studies used primary reinforcers that needed to be experienced immediately (Navarick and Millar 1984, Navarick, 1986, Solnick et al 1980.)

In the Logue et al. study (1986) subjects were given very minimal verbal instructions and seated in front of an apparatus with a moveable rod. When the rod was pushed to the left or the right a light would come on, and then a window of time occurred when subjects could push a button to earn points. Each button press rewarded them with one point. Adult female subjects participated in a variety of conditions in which reinforcer amount (how many button pushes were available) and delay to reinforcer were varied. The subjects all made choices that resulted in the highest amount of reward received at the end of the experimental session.

These subjects used a reward maximisation strategy that resulted in self-controlled behaviour. The authors suggested that adult humans showed such consistent self-control because there was no advantage to

acting impulsively; the points were not exchangeable for money until the session was over. The points themselves held very little value, and the best strategy was to maximise them over the course of a session.

Logue, King, Chavarro, and Volpe (1990) conducted a similar series of experiments. Subjects were given a choice between receiving a small number of points after a short delay, or a larger number of points after a longer delay. The trial length was not held constant, and in some conditions the next trial began as soon as the points were collected from the previous trial. Subjects only made impulsive choices when the trial length was not held constant, and choosing the smaller, sooner reward resulted in a greater total amount of reinforcement. Adult humans appear to try to earn the greatest amount of points in these situations.

Flora and Pavlick (1992) manipulated the density of reinforcement using a paradigm similar to Logue et al. (1990). Adult human subjects pressed buttons in order to earn credits exchangeable for money. All of the money was received at the end of the session. Again, the participants always chose to earn the most number of credits possible: they preferred the larger, delayed option when trial length was held constant, and the smaller, sooner option when it was not. Flora and Pavlick suggested that adult humans may be more likely to choose impulsively when the rewards are immediately consumable than when they are points to be saved up, but they did not provide a direct test of that hypothesis.

The results of all the studies reviewed above suggest that the discrete trial paradigm is not an effective tool for measuring impulsivity in adults. Although most adults do act impulsively in the real world, they

show no evidence of this in the laboratory. This may be because the measures are reactive, and the participants are able to determine the aim of the experiment and behave in the most flattering way. It is also possible that the rewards were not very reinforcing. In the Logue et al. (1996) study, the participants only earned a few dollars during the entire session. It is possible the value of the immediate rewards was so low that the participants were not tempted to act impulsively. The delays in these studies were only a few minutes, and that delay might not be long enough to tempt the participants to choose the immediate reward.

Hyten, Madden, and Field (1994) conducted a discrete trial experiment using larger levels of reward and delay. They suggested that the points earned in discrete trial studies are only one part of reinforcement. The argued that there are 3 different levels of delay in these studies: the delay until the points are given (point delay), the delay until the points are exchanged for money or other rewards (exchange delay), and the delay until the money is spent to consume something (consumption delay). An experiment was designed to distinguish these levels of delay. In the point delay condition, the subjects chose between receiving a small number of points immediately, or a larger number of points after a delay of up to 1 minute. All of the points were exchangeable for money after the experiment was over. In this condition, the subjects all chose the delayed choice, showing self-control. In the exchange delay condition, the subjects earned a small number of points that were exchangeable for money immediately after the session, or a larger number of points they could exchange after 1 day, 3 weeks, or 6 weeks. In the

exchange delay condition, all of the subjects chose larger, delayed reward when the delay was one day. However, when the delay was 3 or 6 weeks, 4 out of 6 subjects chose impulsively.

The results of Hyten et al. (1994) suggest that impulsivity can be measured in the laboratory if the delay to the reward is perhaps more than a day. Economists have found similar results using a temporal discounting paradigm.

Indifference Points and Temporal Discounting

A second way to study a preference for delayed rewards is to measure indifference points or the subjective value that an individual or group places on a delayed reward. Temporal Discounting theory states that people discount the value of a delayed reward. The further in the future the reward is, the more it is discounted (Critchfield and Kollins 2001). If a person is given a choice between £1 available immediately, or £10 pounds available in one week, they will probably choose to wait a week for the £10. If they are then offered £1 immediately or £10 in one year, they may switch their preference and choose £1 immediately. The time to the delayed reward is so great, it is worth less to the person than the immediate reward. The discounting may occur because the participant cannot be confident that the reward will be available in the future (Stevenson, 1986), or because they rate their current needs as more important than any future needs.

Temporal Discounting experiments can used to determine the subjective value of a reward that is available at a point in the future. Rachlin (1992) argued that the value of a reinforcer diminishes between the time of the choice and the receipt of a reward. Because humans and animals always choose the subjectively highest value option, the value of a reward can be determined by comparing when it is chosen over other alternatives.

The indifference point is the "pair of alternatives that a subject selects equally often in a choice situation" (Mazur, 1988 pg 37). As in the above hypothetical example, a person may choose to receive £10 rather than £1 when the delay to the larger reward is one week, but not when the delay is one year because the value of the reward discounts more during the longer delay. Sometime between 1 week and 1 year, there will be a point where the person is indifferent between the two alternatives; the delay to the larger reward is discounted to equal the subjective value of the smaller, less delayed reward.

Studies measuring the rate of discounting or indifference points differ from the behavioural studies mentioned earlier. The behavioural studies asked if an individual, or group, have a preference for a smaller sooner reward or a larger later reward when the amount of the reward and delays have been specified. Temporal discounting theory asks how and when does an individual discount the value of a delayed reward.

Rachlin, Raineri, and Cross (1991) presented university students with a hypothetical choice between receiving $1000 immediately, or receiving between $1 and $990 after delays of 1 month, 6 months, 1 year, 5

years, 10 years, 25 years, and 50 years. The experimenter presented the participant with two cards stating the amount of money and the delay to receiving the money; the participants were required to point to the card they preferred. They found that people discounted rewards in a hyperbolic fashion, i.e. the value of a reward delayed in the near future is discounted at a greater rate than a reward available in the distant future. The perceived difference between receiving $1000 now or next year was greater than the perceived difference of receiving $1000 in 24 or 25 years (Rachlin et al. 1991). Participants discount the value of the delayed reward rapidly when then delay is not in the very distant future, and more slowly the further in the future the delay becomes.

Green, Fry, and Myerson (1994) noted research that suggests that children's ability to delay gratification may increase as they get older (Mischel and Metzner, 1962) and hypothesised that people will discount the value of delayed rewards as they mature. The participants in their study were a child group (12-years-old), a young adult group (mean age 20) and an older adults group (mean age 68). The methodology was the same as Rachlin et al. (1991) As the delay to the reward increased, the value of the reward was discounted most rapidly by the children, less rapidly by young adults, and least by older adults. All of the groups discounted the rewards in a hyperbolic fashion. Green et al. (1994) suggested that older adults have more experience with delayed rewards, and better understand the value of waiting for them.

In a follow-up study, Green, Myerson, Lichtman, Rosen, and Fry (1996) hypothesised that the differences seen between the two groups of

adults (Green et al., 1994) may have been due to differences in age or income level. In the second study, the participants were categorised as young adults (mean age 33 years) or older adults (mean age 70 years) and as upper or lower income. The methodology was identical to Rachlin et al. (1991). They found no differences in the discounting function between adults of the same income level, but lower income adults of both age groups discounted the value of the delayed reward more rapidly than higher income adults. Green et al. (1996) combined the data for the two studies, and suggested that when income is held constant the rate of discounting decreases rapidly between 20- and 30-years-old, and then becomes stable for the remainder of adulthood.

Temporal Discounting has been more successful than discrete trial procedures in measuring impulsivity in adults. The data can help researchers predict how people discount the value of delayed rewards. The limitations of the methodology are that the rewards the participants choose from are all hypothetical; it is possible that people would respond differently if real money was offered.

Individual Differences

The behavioural approach and temporal discounting theory are both interested in how changes in reinforcer amount and delay affect a person's choice. Personality theorists have explored how a person's traits or characteristics interact with the environment to influence their

preference for delayed rewards (Matthews, Schwean, Campbell, Saklofske, and Mohamed, 2000; Mischel; 1984).

Delay of gratification is considered part of a process called self-regulation, which is defined as any effort by a person to alter their own responses or as "self-stopping". When a person intervenes to stop themselves from doing something, such as spending money or smoking a cigarette, they have stopped themselves from doing something that is not in their long term interests (Baumeister, Heatherton, and Tice, 1994).

Self-regulation occurs when "willpower" overcomes more immediate desires (Baumeister et al., 1994). When a dieter succumbs to their hunger and eats cake, they shown have a failure of self-regulation. When she avoids eating cake, her will is overriding their hunger. This is called transcendence and it is the equivalent of self-control; it occurs when a person sees beyond their immediate environment to their long range meanings and consequences.

Whereas the behavioural approach and temporal discounting theory are measured by clearly designed paradigms, self-regulation theory has emerged from a variety of different experimental approaches. The current review will focus on studies that utilised a preference for larger, delayed rewards with other personality traits. Several studies have investigated if a person who prefers larger, delayed rewards in the laboratory will also exhibit self-control and transcendence in other areas of their lives. Personality theorists hypothesise that the skills a person needs to delay gratification in the laboratory may also be skills that help them succeed in the real world (Metcalf and Mischel, 1999)

Meeting their goals requires a person to delay immediate gratification in favour of longer, more rewarding consequences in the future. Funder, Block, and Block (1983) found that preschool boys who showed a poor ability to delay gratification were also rated as irritable, fidgety, and aggressive by their classroom teacher. Their female counterparts were judged as sulky or whiney. The authors suggested that the ability to delay gratification is related to "ego control." A person with strong ego control "would be expected to manifest clear and even excessive separation between need states and behaviour (Funder et al., 1983, pg 1199).

Mischel, Shoda, and Rodriquez (1991) found that ability to delay gratification at age 4 was related to the academic and social success at the age of 15. Furthermore, children who delayed gratification at age four had higher scores on college entrance exams than children who did not delay gratification. This research will be discussed in more detail in Chapter 3; which explores individual differences in children's ability to delay gratification. The current chapter will review research that has been conducted with adolescents.

Funder and Block (1989) interviewed 14-year-olds over the course of 6 sessions. The students chose to receive $4 after each session, or wait until the end of the sessions and receive a lump sum payment of $24 plus $4 interest. The authors found that the students who chose to wait for the larger, delayed payment rated themselves as being more responsible, productive, ethical, and interested in ethical matters. The students who chose to accept the smaller payments rated themselves as more rebellious,

unpredictable, and hostile. A preference for delayed rewards was also found to positively correlate with IQ.

A preference for smaller, immediate rewards has been found to correlate with drug use and behavioural difficulties in adolescents (Wulfert, Block, Santa Ana, Rodriquez, and Colsman, 2002). Adolescents ages 14- to 18-year-olds were given a choice to receive $7 immediately, or $10 after a delay of 1 week. The students had been categorised as "problem" or "non problem" depending on whether they had received disciplinary sanctions any time within the past year, and they also filled out a confidential questionnaire about any drugs they had taken in the past year. Wulfert et al. (2002) found that 81% of the problem students chose the immediate reward, and whereas only 22% of the non-problem students made the same choice. Furthermore, choosing the immediate reward showed a significant positive correlation with the frequency of use of cigarettes, marijuana, and with binge drinking. These data suggest that a preference for immediate rewards is a trait that is linked to other behaviours, and can discriminate problem from non problem students. Self-regulation theorists suggest that the ability to delay gratification is a personality characteristic. They note that people who are impulsive in one area of their lives tend to be impulsive in others as well, for example alcoholics are more likely to smoke than non-alcoholics. (Strayhorn 2002).

Summary

The study of self-control has been investigated from a variety of perspectives. The behavioural approach asks if participants exhibit self-

control or impulsivity in specific laboratory conditions. The participants are given repeated opportunities to choose between receiving a small amount of a reward available immediately or a larger amount after a short delay. Numerous studies have found that non human animals prefer smaller, immediate rewards (Ainslie, 1974; Rachlin, 1972) and that adult humans prefer larger, later rewards (Logue et al., 1986). Adults show such a consistent preference for the larger, delayed rewards in discrete trial tasks that it has been difficult to manipulate the dimensions of reward and amount to determine the reinforcement conditions under which they may switch their preference to smaller, immediate rewards. These studies do tell us that adults are skilled at judging reinforcer amount and delay and maximising their total reward.

As there is ample evidence in every day life that adult humans do sometimes make impulsive choices, it is fait to conclude that the discrete trial methodology is not a very sensitive tool for studying self-control and impulsivity in human adults.

Temporal Discounting theory provides a more sensitive measure of when people prefer larger, later or smaller, sooner rewards. In a typical experiment, subjects are asked if they prefer to receive small amounts of hypothetical money after a short delay, or a larger amount of hypothetical amount of money after longer delays. Rachlin et al. (1991) found that adults discount the value of delayed rewards in a hyperbolic fashion, i.e. rewards lose subjective value more quickly in the near future than in the distant future. Green et al. (1996) confirmed that people discount delayed rewards in a hyperbolic fashion, and that the rate of discounting is related

to a person's income and age. Their data do not suggest a causation; it is not clear if a preference for larger, delayed rewards increases a person's chances of having a higher income or if a higher income makes a person more willing to wait for a larger monetary reward. Personality theorists have further explored the relationship between a preference for delayed rewards and personality traits and characteristics.

A preference for larger, delayed rewards has been found to be positively associated with greater academic success (Shoda et al., 1990) and negatively correlated with drug and alcohol use (Wulfert et al, 2002). Metcalf and Mischel (1999) hypothesise that individuals who can wait for larger, delayed rewards is an important component of emotional intelligence, and may be of use in understanding self-defeating or self-destructive behaviours.

The combination of these approaches show that adults are skilled at judging reinforcer amount and delay and can maximise the amount of reward when there is little incentive to choosing impulsively. When the delays to the larger reward, the reward loses subjective value and people rate immediate rewards as having a higher subjective value. And different people will assign a different subjective value to the delayed rewards.

None of these approaches tell us how people develop a preference for delayed rewards. It is possible that self-control is a skill that children develop as they get older? Or, is self-control a skill that some people are more adept at than others? The following chapters will review literature that relates to these two hypotheses.

Chapter 2: The Development of Self-Control

A preference for larger, delayed rewards over smaller, sooner rewards is a considered necessary skill for succeeding in the modern world (Baumeister et al., 1994; Logue, 1995). Logue (1995) suggests that infants have no ability to delay gratification and demand that their needs are met immediately. By the time a person reaches adulthood they sometimes need to delay gratification in order to function well in society; adults need to learn to save money to pay bills, train for a career, and eat a healthy diet and exercise. Sometime between infancy and adulthood people need to learn how and when to wait for a delayed reward, rather than accepting lower value, immediate reward.

I have already described that Green et al. (1994) found that 12-year-old children discount the value of delayed rewards more rapidly than adults, and that a person's rate of discounting slows until the age of 30 when it stabilises. These data suggest that adolescence and early adulthood are a time when people's preference for delayed rewards increases. It is assumed that children's ability to delay gratification improves during childhood (Rachlin, 1995). Few individual empirical studies support this claim, but the aggregate data from many studies and paradigms suggest that children's preference for delayed reward does increase.

Most of the research that has investigated a preference for delayed rewards in children has been conducted using either a discrete trial

paradigm or a delay of gratification paradigm. The main findings from each of these lines of research will be reviewed in this chapter, and then combined with other studies to discuss developmental trends in a preference for delayed rewards.

Discrete Trial Studies

A number of studies have examined self-control in children using a discrete trial methodology. These studies offer children a choice between a small amount of reward available after a short delay or a larger amount of the reward after a longer delay. Previous work using a discrete trial methodology has found that adult humans exhibit self-control in the laboratory; when given a choice between receiving a small amount of a reward immediately, or a larger amount of the same reward after a short delay, adults typically choose the delayed reward (Logue et al., 1986, Millar and Navarick, 1984, Navarick, 1988). Non-human animals show an almost exclusive preference for the smaller immediate reward under similar circumstances. Most studies using a discrete trial methodology have failed to find that children's preference for delayed rewards increases as they get older.

Logue and collegues (Logue and Chavarro, 1992; Logue, Forzano, and Ackerman, 1996) hypothesised that the disparity of results between adult humans and animals may be because adults have an advanced language ability, which enables them to count time and develop verbal strategies for maximising rewards. They suggested that young children

may develop a preference for larger, delayed rewards as they get older and their language abilities increase.

Logue and Chavarro (1992) examined 3- to 4-year-old children's preference for delayed rewards. They sought to replicate the paradigms used with adults and animals, and to establish normative data about young children's preference for delayed rewards. At the start of the session, an experimenter presented children with a cheerful looking display that contained two drawers. The drawers were identical in appearance on the outside, but differed in colour on the inside. The children participated in the study for a total of four sessions; the first two sessions were baseline measures to determine if the children had a preference for either drawer: if the child chose either drawer they were rewarded with 2 stickers after a 15 second delay. During the third and fourth sessions, the children chose between one drawer that produced 3 stickers after a 30 second delay and one drawer that produced 1 sticker after no delay. The length of time between each trial was always 1 minute, to ensure that the session length was constant regardless of the children's choices. Logue and Chavarro found that the children did not show a preference for either the smaller sooner (SS) or the larger later (LL) reward. They did not test for a correlation between the children's language ability and their choices of larger, delayed rewards.

Logue, Forzano, and Ackerman (1996) continued this research with a larger sample of children. They studied 3 groups of children, aged 3-, 5-, and 7-years-old. The children were tested on the same apparatus as Logue and Chavarro (1992), and the reward was one half a raisin or chocolate.

The children were not allowed to eat for two hours prior to participating in the research, to ensure that edibles would be potent reinforcers.

One half of the sample participated in three standardised language tests and participated in 4 sessions, identical to those used by Logue and Chavarro (1992). The other half of the sample participated in 8 sessions. The first two sessions were baseline measurements of the children's preference for either drawer. During the third and fifth sessions, the children could receive either 1.5 pieces of food or .5 piece of food after 15s. These sessions tested whether the child preferred to receive a larger amount of a reward. In the fourth and sixth trials the children chose between 2 bits of food after 0 or 30s, to determine if they preferred immediate rewards. During the final two sessions, the children chose between three pieces of food after a 30 delay or one piece right away.

The 3- and 7- year-olds did not show a preference for the larger later reward over the sooner smaller reward, only the five-year-olds made significantly more self-controlled than impulsive choices; they chose to wait longer to receive more food. The data further revealed that only the 7-year-olds showed a preference for the larger reward when delay was held constant, and a shorter delay when reward was held constant. The younger children chose the larger reward and shorter delay slightly more than half the time, but not more than what would be expected by chance. The authors suggested that children do not show behavioural sensitivity to reinforcer amount and delay until age five.

Logue et al. (1996) reported that their data are consistent with the hypothesis that children make more self-controlled choices as they grow

older. They found that the 5-year-olds showed more self-control than the 3-year-olds, but the data from the 7-year-olds were too variable to be conclusive. The scores on the language tests did not correlate with the number of self-controlled choices the children made. However the authors suggested that their language assessments may not have been sensitive enough because they did not specifically test children's ability to count or measure time.

The results from these experiments (Logue and Chavarro, 1992; Logue et al., 1996) are difficult to interpret. The 3- and 5-year-old children did not exhibit a preference for the larger rewards when delay was held constant or the immediate reward when amount was held constant. It is possible that the children did not prefer delayed rewards in these studies because the differences in amount or delay were not salient. The difference between the small reward (.5 a raisin or m&m) and the larger reward (1.5 raisins or m&ms) may have been so small that it was not important to the children. Furthermore, the 3-year-olds in both studies showed a pattern of alternating the side of the display they chose their reward from – which is what they were first asked to do during the forced choice trials. This pattern of responding suggests that the children may have formulated a rule about how best to respond in this experiment, and followed that rule rather than developing any other strategies based on the amount and delay of the reward. It cannot be concluded from the study that children's preference for delayed rewards increases as they get older because the 5-year-olds made more delayed choices than the 7-year-olds. However, the data from the 7-year-old children were so variable that

it may suggest that there are large individual differences in children's preference for delayed rewards rather than an increased preference for delayed rewards as a child gets older.

Darcheville, Rivière, and Wearden (1992) also found large variability in the responses of 5- and 6- year-old children using a similar paradigm. Children in this study were given a choice between watching 20 seconds of a cartoon after a 0.5 second delay, or 40 seconds of a cartoon after a 40 second delay. The inter-trial interval was kept constant so that the same amount of time elapsed between the end of one trial and the beginning of the next trial. Out of 16 subjects, only 4 consistently chose the larger, delayed reward. Seven children consistently chose the smaller, immediate reward, and the remaining 5 subjects showed no preference. The main intent of the authors was not to investigate the variables that affect children's preference for delayed reward, but to determine the correlation between impulsive behaviour and performance on a FI interval schedule. They found that children who made impulsive choices in the self-control paradigm were also insensitive to the temporal contingencies on the FI interval schedule. Their data indicate that FI interval schedules may be helpful in identifying children who will behave impulsively in this self-control paradigm.

The studies by Logue (Logue and Chavarro, 1992, Logue et al, 1996) and Darcheville et al., (1992) failed to find the same consistency in responding in children that has previously been seen in adult subjects and non-human animals. Only Logue et al. (1996) found a significant preference for self-control in 5-year-old-children, but not in 3- or 7- year-

olds. Darcheville et al. (1992) did not find significant self-control or impulsiveness in 5- and 6-year-olds. It is not possible to conclude from these studies if a preference for delayed rewards increases with age; it is possible that the participants in these studies did not understand the paradigm or did not find the rewards reinforcing. In Logue's studies the 3- and 5-year-old children did not exhibit a preference for the larger reward over the smaller reward when the delay was held constant. It is also possible that there are large individual differences between children, and consistent preferences may be hard to find.

Sonuga-Barke, Lea, and Webley (1989a, 1989b) used a slightly different discrete trial paradigm to determine if children's sensitivity to delay and amount increases as they get older. They suggested that it is not always advantageous to wait for a delayed reward, if a small reward is available immediately and a large reward is available after a delay; a participant can sometimes earn more overall reward by choosing the smaller reward if one trial starts as soon as the rewards are dispensed from the previous trial, and the session lasted a fixed amount of time. In their paradigm, children chose between two initial links, the first led to small number of tokens available after 10 seconds, and the second link rewarded them with more tokens after longer delays. In these experiments the post-reinforcer delay was not manipulated to ensure that all trials were the same length, rather the entire session was of a fixed length. Therefore, if the trial had a long delay, subjects could best maximise their rewards by choosing the smaller, less delayed rewards because they could earn more rewards during the entire length of the session. They

hypothesised that children's sensitivity to the joint effects of delay and amount would improve with age.

Sonuga-Barke et al. (1989a) presented 4-, 6-, 9-, and 12-year-old girls with a choice between receiving one token after 10s, or two tokens after delays of 20s, 30s, 40s, or 50s. The children participated in 5 sessions and the delay to the larger reward was consistent throughout each session. The delay sessions were presented in ascending order, and each experimental session lasted 15 minutes. They found that 12-year-old children were able to take into take into account both the delay and amount of reward and made choices that earned them the largest number of rewards during the session. When the delays to the larger reward were short, the older children chose the delayed reward and maximised their total number of points for the session; they chose the immediate rewards when the delays to the larger reward were longer. The 6- and 9- year-old children were more likely to wait for the larger, delayed rewards, even when the delays were long and they earned fewer rewards during the course of the entire session. The choices of the 4-year-olds were inconsistent; they either were indifferent between the two reward alternatives, or they chose the smaller, immediate reward. Sonuga-Barke et al. (1989a) suggest that 6- and 9-year-olds are primarily sensitive to reward size, and do not take the delay into account when making choices. They suggest that the 6- to 9-year-olds are learning how to wait for rewards, and the older children are learning when to wait.

In a follow-up study (Sonuga-Barke et al. 1989b) a choice of 3 tokens after a delay of 30s was paired with a choice of 2 tokens after 25 or

65s or 4 tokens after 25 or 65s. Six-, nine, and twelve- year-old girls participated in the experiment. The length of the delays were the same as reported in the earlier experiment, and the delay associated with each link was consistent during the session, but the delays were presented in a mixed order. The 6- and 9-year-olds were insensitive to decreases in reinforcer density brought on by increases in delay; they tended to choose the schedule that gave them the larger reward, even if this meant less overall reinforcement. The data from the 12-year-olds were mixed, only some of the children were able to take delay and amount into account to maximise their rewards. The authors suggest that the 12-year-olds were less successful in this experiment than the previous one (Songua-Barke et al 1989a) because the delays were presented in pseudorandom order, rather than in an ascending sequence. They concluded that children's maladaptive choices may have been due to an inability to adapt to delay. The data still suggest that children's sensitivity to reinforcer amount and delay increases as they get older because nearly all of the younger children selected the delayed reward even when it did not maximise the total number of rewards; whereas the older children showed that they were beginning to understand when it was beneficial to wait.

In a further study, Sonuga-Barke et al (1989b) tested the hypothesis that 6-year-old children are not sensitive to delay. Six- and twelve-year old children were presented with a choice of an adjusting schedule and a standard schedule. If they chose the adjusting schedule, the length of the delay would increase on that schedule for the next trial, if they chose the standard schedule the length of the delay on the adjusting schedule would

decrease. They could earn 2 tokens by choosing the adjusting schedule and 1 token by choosing the standard schedule. The 6-year-old children favoured the adjusting schedule, even though they sometimes experienced delays of up to 10 minutes for the delayed reward. Their choices were maladaptive in that they did not maximise their total reward, the 12-year-olds were more sensitive to amount and delay and earned more overall reward. The authors noted that by traditional definitions of self-control (Logue, 1995; Mischel, 1981) the six-year-olds willingness to wait for a delayed reward was exceptional self-control. However, the children did not earn the maximum amount of the reward and therefore their preference for delayed rewards was maladaptive.

The findings of Sonuga-Barke et al.(1989a, 1989b) did find improvements in children's sensitivity to amount and reward as they get older. These findings differ from other discrete trial studies (Darcheville et al, 1992; Logue and Chavarro, 1992, Logue et al., 1996), which failed to find consistent responding in a self-control paradigm using 5- to 7- year old children. The primary difference between these studies is that in the Sonuga-Barke et al. (1989a, 1989b) paradigm, the sessions were constrained by the amount of time the child had to earn rewards, when the delays to the long reward were long it was most adaptive to choose the immediate rewards. In the studies by Logue et al. (1996) and Darcheville et al. (1992) there were a limited number of trials, so to earn the maximum amount of reward the child would always choose the delayed reward.

It should also be noted that Sonuga-Barke et al (1989a, 1989b) rewarded the children with tokens that they could spend when the session was over on sweets or toys. Logue et al. (1996) and Darcheville et al. (1992) rewarded the children with food or a movie which was immediately consumed. Flora and Pavlick (1992) suggest that when consumable, intrinsic rewards are offered, adult subjects are more likely to behave impulsively . When conditioned reinforcers, such as tokens or points that have to be saved up until the end of the session are used, subjects are more likely to act in a self-controlled manner. Perhaps Sonuga-Barke et al. (1989a, 1989b) found the children preferred the delayed rewards because of the nature of the rewards, they needed to wait until the end of the session to consume them, and because the session was a fixed length there was no advantage to choosing impulsively. These studies have all found that children respond differently in a self-control pattern at different ages. However, the studies are difficult to compare due to the differences in paradigms and the types of reinforcers used.

The data from Sonuga-Barke (1989a, 1989b) do not answer the question of whether a preference for delayed rewards increases as children get older. Their paradigm was designed to test if a child's sensitivity to reinforcer delay and amount increases as a child matures. The children could sometimes maximise the total amount of reward by choosing the smaller, immediate reward. Although the data tell us that children become more sensitive to the factors necessary to maximise rewards, they do not tell us if children's tolerance for delayed rewards,

when waiting for a delayed reward increases maximisation, increases with age.

All of the studies reviewed (Darcheville et al., 1992; Logue and Chavarro, 1992; Logue et al., 1996, Sonuga-Barke et al., 1989a) found that 3- and 4-year-old children are indifferent to delay and amount or prefer smaller, immediate rewards. It is tempting to conclude that young children have not developed effective strategies for waiting for delayed rewards. However, Mischel and collegues (Mischel and Ebbson, 1970) have found that 4-year-old children will choose to wait up to 15 minutes for a larger reward under certain conditions.

Delay of Gratification Paradigm

Mischel and colleagues (Mischel & Ebbson, 1970, Mischel, Ebbson, & Zeiss, 1972) examined children's preference for delayed rewards using a single trial delay of gratification paradigm. They were interested in the environmental conditions that would help a child wait for delayed rewards. In a series of studies, young children were brought one at a time into a small room with a table. On the table was a small bit of a preferred food and a bit of a lesser preferred food. The children were told that the experimenter needed to leave the room; the children could call the experimenter back into the room at any time. If they waited until the experimenter returned on his own, they could eat the preferred reward; if they called him back before he returned of his own volition, they could eat the less preferred food.

Mischel and Ebbson (1970) hypothesised that children would have easier time waiting if the rewards were in view, they reasoned the presence of the rewards would remind the children why they were waiting and enable them to wait longer. Contrary to their hypothesis, they found that the 3- to 5- year-old children waited longer when the rewards were obscured during the delay period. In one condition, the experimenter took the rewards with him when he left the room, and in the other condition the rewards were left in front of the children. When the rewards were not in view, 6 out of 8 children waited the full 15 minutes for the experimenter to return so they could eat the preferred reward. All of the children in the rewards exposed condition summoned the experimenter back before 15 minutes and were rewarded with the less preferred food. The average waiting time in the rewards exposed condition was one minute and three seconds. The children in the rewards unexposed condition kept themselves busy during the delay period by singing, taking to themselves, making up games with their hands and feet, and falling asleep. The authors suggested that the presence of the rewards was tempting for the children, and therefore they ended the experiment sooner when the rewards were visible.

In a similar paradigm, children were able to wait longer while they are viewing slides of the relevant reward than they are when viewing slides of other rewards or when the actual rewards are in full view (Mischel and Moore, 1973, 1980) The authors suggest that viewing the rewards on slides allows the children to ideate in different ways than when the rewards are in full view. Viewing the rewards on the slides

helped remind the children what they were waiting for, but in an less arousing way that viewing the actual rewards.

In a follow-up experiment, Mischel, Ebbson, and Zeiss (1972) gave children various tasks to help them wait for the preferred food. The authors reasoned that if children had something to do while waiting, it would help keep their minds off the rewards and they could wait longer. All of the children were left to wait for the experimenter with the rewards in full view. One group of children were given no instructions, one group were given a toy to play with, and the final group were told to think about fun thoughts while they waited. The children who were given no instructions waited an average of 30s, the children in the toy condition waited for 8.59 minutes, and the children who were told to think fun thoughts were able to wait an average of 12.12 minutes. In a follow-up study, children were told to either to think fun thoughts, sad thoughts, or thoughts about the reward. They found that the children who were instructed to think fun thoughts waited almost 13 minutes, while the children in the other two conditions waited less than five minutes. In a final study, the children were also given suggestions of things to think about, but in this condition the rewards were not in view. The children were able to wait for most of the 15 minute delay when they were told to think fun thoughts (14.48 minutes), or were not given any instruction about what to think about (12.86 minutes). However, when the children were told to think about the rewards, they were unable to wait one full minute. These studies suggest that different mental strategies may help people delay gratification and wait for larger, delayed rewards. It is

possible that individuals who are better at waiting for delayed reward have devised effective mental strategies, and perhaps these do develop as children get older. The preschoolers in Mischel et al.'s (1972) study only waited for the delayed rewards when they were given instructions to think about happy thoughts or about things other than the rewards, perhaps young children can benefit from these strategies but are not yet able to employ them independently.

A study by Yates, Lippett, and Yates (1981) did find that children wait longer for a reward when they are instructed to think about happy thoughts, and that older children are able to use these strategies with fewer instructions than younger children. In their study children were shown a box of toys they could win by playing a game called "the lucky dip." Each child was shown a lamp that had three distinct bulbs. They were told that every time a bulb lit, they would get one turn in the lucky dip game. The first bulb was lit at the start of the session and the others were lit at regular intervals over a 16 minute period. The children could wait until the session was over and have four turns, or stop the session at any time and have as many turns as there were bulbs were lit on the lamp.

The researchers hypothesised that the children would wait longer if they experienced a positive affect induction. Prior to the beginning of the waiting task, the children were asked to talk about things that made them happy. In the positive induction condition the children spoke about what made them happy and then began the experiment; in the cognitive instruction group they spoke about what made them happy, and then the experimenter suggested that they think about those things while they

waited. A control group of children discussed neutral topics with he experimenter prior to the waiting. Five year old children waited longer in the cognitive instruction condition than in the postive affect induction condition or the control group. The 7 and 8 year old children waited equal amounts of time in the positive affect induction and cognitive instruction, and less time in the control condition. Although they were not explicitly told to think about happy thoughts while they were waiting, the older children appeared to benefit from a discussion about things that made them happy before the experiment, whereas the younger children needed to be told to continue thinking about the happy thoughts.

A more direct way to measure children's thoughts is to study their verbalisations. Eight-year-old children were found to be better able wait in a delay of gratification task than five-year-olds and three year-olds. (Miller, Weinstein, and Karniol, 1978). The children were brought into a room and shown plates with 1 or 2 marshmellows and a blinking red light. The child was told that the experimenter needed to leave the room, if the child waited until the experimenter returned on his own, she could have 2 marshmellows. Or, she could call him back at any time but then she is only allowed 1 marshmellow. The children were each given one of these three statements to verbalise every time the red light blinked: in the task-oriented condition the children were told to verbalise "I am waiting for the marshmallows", in the reward-oriented condition the children were told to say "The marshmallows are yummy," and in the irrelevant verbalisation condition the children were asked to count from one to

three. In the no-verbalisation condition the children were simply told that the light may blink while they were waiting.

During the verbalisation conditions no differences were found between the amount of time the 5- and 8-year-olds waited. They waited the longest in the task oriented condition and the least amount of time in the reward oriented condition. During the no-verbalisation condition the 3-year-old children waited an average of 388 seconds, and the 8-year-olds waited an average of 685 seconds. Miller et al. (1978) noted that the 5-year-olds waited the same amount of time in the no verbalisation and reward oriented conditions.

Toner and Smith (1977) found different results with 4- and 6- year-old girls. The children were seated at a table across from the experimenter. The experimenter placed one piece of candy in front of the child, and told her that she could take and candy now or wait for more. Additional pieces of candy were added every 30 seconds for 10 minutes. During the session a red light was flashing. The children were told to make one of the following vocalisations when the light flashed. In the rule verbalisation condition the children said "It is good if I wait;" in the neutral condition they counted to five; during the reward verbalisation condition they said "the candy will taste good;" and they were given no instructions in the no verbalisation condition. The no-verbalisation the older children waited twice as long as the young children; replicating Miller et al. (1978). However, in the rule verbalisation and neutral verbalisation conditions the younger children waited significantly longer than the older children. The 4-year-old girls were able to wait for the most time in the rule

verbalisation condition, and the 8-year-olds waited longest in the no-verbalisation conditions.

Mischel and Mischel (1983) confirmed that children's knowledge of effective self-control strategies increases as they get older. Children ages 4-, 8-, and 12-years old participated in the research study. The children were all told about the delay situation where a person can wait for 2 pieces of food or call the researcher into the room and only receive 1 piece of food. The children were asked questions about what strategies they could use to help them wait longer if they were put in that situation.

The 4-year-old children were interviewed in a small room at their nursery. The older children were given booklets with a description of the delay task, and a series of questions to answer. The children were asked if it would help them wait longer if the marshmallows were covered or exposed. The 8- and 12-year-old children significantly believed that covering the rewards would help them wait longer, whereas the younger children did not have a consistent preference. The children were also presented with a choice between task ideation strategies, such as saying "I am waiting for the marshmallows" or using consummatory ideation strategies, such as saying "The marshmallows taste yummy and chewy." The 8- and 12-year-olds believed they would wait for longer if they used task utilised the task rather than consummatory ideation strategies, whereas the preschool children showed no preference. These findings confirm that young children are less knowledgeable than older children about what will help them wait but can benefit from waiting situations that utilise these strategies.

Although the children in Mischel and Mischel's (1983) study may have known about strategies to help them wait, it is possible that their expectations of the wise choice is not always how they behave. Nisan and Koriat (1978) offered 5 year old children a choice between 1 piece of candy available immediately, or 2 candies after waiting one day. The children were also told about another child the experimenter knew; half of the children were told about a smart child and the other half were told about a stupid child. The participant was then asked what the smart (or stupid) child would choose in the same situation. The order that the questions about the child's own choice and about the smart/stupid child were presented in a counterbalanced order. Seventy-nine percent of the children said that the smart child would choose the delayed reward, but only 48% children made that choice themselves. The children's responses about the stupid child's choice did not differ significantly from their own choice. In a follow-up study, the children were given the choice themselves, and also asked what was the worthwhile choice. Again, 70% of the children stated that it would be worthwhile to wait for the delayed reward, whereas only 26% chose the delayed reward. This suggests that even when children understand that it is preferable to wait for a larger delayed reward, they may still have a preference for smaller, immediate rewards.

Schwarz, Schrager, and Lyons (1983) asked 3-, 4-, and 5-year old children to choose between a low value food or toy available immediately or a higher value reward available after a delay of 7 or 24 hours. The children chose to receive the delayed rewards 60% of the time when the

delay was 7 hours, but only 32% of the time when the delay was 24 hours. There was no effect of age, the older and younger children equally preferred the delayed rewards, and the children's preference for delayed rewards was not correlated with their results on the Stanford-Binet IQ test. The children's different responses to different levels of delay suggests that they understood the amount of time they had to wait.

Mischel and Metzner (1962) found that age and IQ are correlated with the ability to delay gratification in older children. Children ages 6-12 were offered a small candy bar immediately or a larger candy bar after delays of 1 day to several weeks. They found that 71% of the 6-9 year old children chose the immediate reward when the delays were between one day and two weeks, whereas only 20% of the children ages 10-12 chose the smaller candy bar at the same time intervals. The children's results on IQ tests positively correlated with the amount of time they were willing to wait for the larger reward. This research suggests both that children's preference for delayed rewards increases as they get older, and there are individual differences within children's preferences.

Conclusion

Preference for Delayed Reward in Childen ages 3- to 5

It is not clear from the data if young children are able to consider amount and delay of reward to determine if they prefer to wait for a delayed reward. Using discrete trial paradigms researchers have found

that children ages 3- to 5-years-old are impulsive or indifferent to delay and amount (Darcheville et al. 1992; Logue and Charvarro, 1992; Logue et al, 1996; Sonuga Barke et al 1989a, 1989b). The children in these studies did not exhibit a preference for a large, delayed reward or a smaller, immediate reward. However using a delay of gratification paradigm, Mischel (Mishel and Ebbson, 1970, Mischel et al, 1972; Mischel and Moore, 1973, 1980) found that 4-year-old children will wait up to 15 minutes for a preferred piece of food with the rewards were not in view during the waiting (Mischel and Ebbson, 1970); when they had something to do during the wait (Mischel et al. 1972); when they were told to think happy thoughts (Yates et al, 1981), or when they could view a photograph of the rewards (Mischel and Moore, 1973, 1980). When these conditions were not met, the children did not wait as long for the rewards, suggesting that is was not just the design of the study that enabled the children to wait longer.

However, there are important differences between the discrete trial and the delay of gratification paradigms. In the discrete trial paradigms, the children received their rewards from an apparatus and had no social contact during the study. There was more of a social component in the delay of gratification paradigm; the children had to wait for an adult to return to the room to receive the larger reward. Although the children chose not to wait in several condition suggesting that that they did not feel obligated to wait for the adult, the social component may have helped them to wait when the conditions were right. Also, the children in the discrete trial experiments only chose if they were going to wait or not; in

the delay of gratification paradigm the children could chose to wait but had to maintain their choice, they could change their mind and call in the experimenter at any time. It is possible that if they had to make one choice in the beginning: either to wait for the experimenter to return on his own or now, they may have chosen more impulsively. In the discrete trial studies, the children needed to inhibit making an impulsive choice only at the time the choice was made, whereas in Mischel's studies, the children needed to continually inhibit calling the experimenter back into the room.

Mischel and Mischel (1983) found that 4-year-olds were not very knowledgeable about which strategies will help them wait for a delayed reward, and in the delay of gratification paradigm they only waited when told to use a strategy or when the environment was arranged in such a way to help them wait. It is possible that the children in the discrete trial studies would have waited longer if they had been given more suggestions how to wait.

Finally, in the discrete trial experiments the children were asked to choose repeatedly between a small, immediate or a larger, later reward. In the delay of gratification paradigm the children only received 1 trial. None of the discrete trial experiments conducted reported the children's preferences on each trial, but it is possible that their preference for delayed rewards decreased as the session progressed. Perhaps if the children in the delay of gratification paradigm were asked to repeat the procedure more times they would have switched their preference or shown overall indifference between the two alternatives.

Preferences for Delayed Rewards in 5- to 12- year-olds

Rachlin (1995) posits that children's tolerance for delayed rewards increases as they get older, but only a few studies support this claim. Mischel and Mischel (1983) found that children's knowledge of waiting strategies improves between ages 4- and 12-years-old, and Sonuga-Barke et al. (1989a, 1989b) found that children's sensitivity to delay and amount also improves between 4- and 12-years. These studies suggest that children's understanding of how and when to wait improves as they get older, but the research did not address their preference for delayed rewards.

Mischel and Metzner (1962)found a developmental difference that 10- to 12-year-olds were more likely than 6-9 year-olds to choose a larger candy bar that was delayed 2 weeks rather than a small candy bar available immediately. Yates et al. (1981) found that 7-and 8-year-olds were better able to wait than 5-year-olds after they spoke about happy thoughts, but were not explicity told to think about those thoughts while waiting. Yates el al.'s data suggest that children need less instruction on how to wait as they get older. Miller et al. (1978) and Toner and Smith (1977) both found that 8-year-old childen were better able to wait for a delayed reward than 3- to 5-year-olds when they were not given any instructions of things to say to help them wait. Taken together, these studies suggest there may be a developmental shift in children's preference for delayed rewards between ages 5 and 8, and possibly another shift between ages 9 and 10.

Several studies reviewed in this chapter found evidence for individual differences in children's preferences for delayed rewards. Logue et al. (1986) and Darcheville et al. (1992) found inconsistent responding in 6- and 7-year-olds on a discrete trial task. Mischel and Metzner (1962) found that IQ was positively correlated with a preference for larger, delayed rewards. These data suggest that some children may have a greater preference or ability to wait for larger, delayed rewards than others. Chapter 3 will review literature that supports the hypothesis that a preference for delayed rewards is a trait that varies between individuals.

Chapter 3: Individual Differences in Children's Preferences for Delayed Rewards

The research reviewed in Chapter 2 suggested that there may be developmental changes in children's ability to delay gratification. An alternative theory is that the ability to delay gratification is a trait that varies among individuals, with some people better able than others to wait for larger, delayed rewards. These individual differences may be seen between individual children in a typical population, and more dramatically between typically developing children and those with behavioural problems. Or perhaps individual differences in a preference for immediate rewards is not independent of development. Children may differ in their ability to wait for delayed rewards, and most children will improve in their ability to tolerate delay, but some will always have a greater preference for delayed rewards.

A preference for immediate rewards has long been noted as characteristic that varies between individuals. Eysenck and Rachman (1965) suggested that all personalities can be broken down into two dimensions: neuroticism/emotional stability and extroversion/introversion. Impulsivity, or a preference or immediate rewards was characterised as an unstable attribute of extroverts. Children with conduct disorder, people who suffer from obesity and other eating disorders, those with addictions, and hyperactive children all show a preference for smaller, immediate rewards (Strayhorne, 2002)

Many studies have found that children who suffer from ADHD are more likely than their peers to choose a smaller, immediate reward instead of a larger, more delayed reward (Rapport, Tucker, DuPaul and Stoner, 1986; Schweitzer and Sulzer-Azaroff 1988, 1995; Solanto et al., 2001; Sonuga-Barke, Taylor, Sembi & Smith 1992a; Sonuga-Barke, Taylor & Hepinstall, 1992b).

The following chapter will review literature that considers if a preference for larger, delayed rewards is correlated with other characteristics such as intelligence and social skills in children. Correlations may suggest that the two skills are related, or share an underlying motivation. Variations in self-control will also be explored within clinical populations such as children with ADHD.

The Relationship between Self-Control and Individual Characteristics

Several studies have explored the relationship between a preference for delayed rewards and other individual characteristics. It has been found that choices of delayed rewards are correlated with intelligence (Mischel and Metzner, 1962) social and academic competence (Mischel et al., 1988; Shoda et al., 1990), and attention span (Funder et al., 1983). A preference for smaller, immediate rewards is associated with hyperactivity and inattention (Sonuga-Barke et al., 1992; Schweitzer and Sulzer-Azaroff; 1996; Solanto et al., 2001).

Mischel (1984) suggested that individual abilities to postpone gratification interact with situational variables to determine how long a

person will wait for a delayed reward. Mischel and colleagues established that 4- and 5-year-old children wait longer for a reward if if the rewards are out of sight during the delay period (Mischel and Ebbson, 1970), if they could view slides of the reward rather than view the rewards themselves during the delay (Mischel and Moore, 1973, 1980), if they were given a toy to play with or were instructed to think about happy thoughts during the delay, or if they thought about non-connsumatory properties of the reward (Mischel et al, 1972). Metcalf and Mischel (1999) suggested that when the children think about the consummatory, arousing, or "hot" features of the reward they are able to wait for less time than if they think about nonconsummatory, informative, or "cool" properties of the reward. In order to successfully bridge a delay, a child must ignore the "hot" properties of the reward while remaining focused on the "cool" properties. It is possible that some children will be inherently more successful at this task than others.

A child who is disposed to prefer larger delayed rewards may wait 5 minutes for a delayed reward when the rewards are in view during the waiting period, and the entire 15 minutes when the rewards are covered. Another child who is less disposed to wait for larger delayed rewards may wait only 1 minute when the rewards are in view, and 5 minutes when they are covered. Although the situation affects how long the children choose to wait, some children will wait longer than others in the same situation. Mischel states "individual differences in the delay paradigm...are not trivial matters; they are, instead, robust prototypical

features of an important and enduring competence." (Mischel, 1984 pg 354).

Mischel et al. (1988) hypothesised that preschooler's ability to wait for delayed rewards may be linked to other personality characteristics when they are older. Children who are able to wait when they are young, may later in life be more cognitively flexible, pursue goals more effectively, and cope better with frustration and stress than children who did not show the same ability to delay gratification. This would suggest that the personality traits associated with a preference for delayed rewards are established in early childhood and are consistent throughout a child's development.

The researchers contacted 95 parents of children who participated in a delay of gratification experiment when they were 4 years-old. The children were 15-years-old at the time of the second assessment. A deviation score was calculated from the children's original delay time, which was the amount of time their delay score deviated from the average delay score of all of the children in their particular experimental condition. It would not make sense to compare the delay time of a child who was in a rewards exposed condition to a child who was in a rewards covered condition (Mischel and Ebbson, 1970). A child who waited longer than their peers in a given condition was given a positive deviation score, and child who waited less than average was given a negative deviation score.

When the participants were 15-years-old, their parents were asked to complete the personality assessment, The California Child Q-set, and to rate their child's academic and social coping abilities.

Mischel et al. (1988) found that children's ability to delay gratification when they were young significantly predicted their social and academic competence when they were older. Children who waited longer in the delay of gratification task were rated by their parents as being more articulate, having better attention spans, better able to make plans and follow them through, and more confident than the children who waited less time. These correlations were all moderately significant. Mischel et al. (1988) suggested that an ability to delay gratification for a larger reward is related to the ability to adaptively cope with social and cognitive challenges. It is possible that the same mechanisms that help a child wait for longer, delayed rewards also help the child develop academic and social competence

Shoda et al. (1990) followed up this study with a larger sample of children, and considered the condition the child participated in during the original experiment. Again, they found that the preschoolers who waited longer than average for a delayed reward in the rewards exposed or when no ideation strategies were suggested were rated by their parents as showing greater self-control in difficult situations, showing better concentration, and being more intelligent than their peers who waited less time than average during the delay task. Furthermore, Shoda et al. (1990) found that the amount of time a child waited when the rewards were exposed or no strategies were suggested positively correlated with their scores on the Scholastic Aptitude Test (SAT) when the participants were 16- or 17-years-old. The SAT is an American college admissions exam that tests vocabulary and mathematical skills.

When the rewards were obscured or ideation strategies were suggested no correlations were found between parent ratings of cognitive or social competence or SAT scores. These conditions may have given children who would normally have low waiting times strategies to help them wait longer. Shoda et al. (1990) suggested that the reason they found significant correlations in the earlier study is because the sample size was small and did not permit between group comparisons. As the sample size increased, the correlations for children in the rewards obscured or ideation strategy conditions became insignificant.

Shoda et al. (1990) suggested that the

> "the qualities that underlie effective self-imposed delay in preschool may be crucial ingredients of an expanded construct of intelligent social behaviour that encompasses social as well as intellectual knowledge, coping, and problem-solving competencies." (Shoda et al. , 1990, pg. 985)

Funder, Block, and Block (1983) also found that children's ability to delay gratification when they were 3-years-old correlated with personality characteristics later in childhood. In the initial experiment, 3-year-old children participated in a gift-delay situation and a resistance to temptation situation. In the gift-delay situation the children were shown a gift wrapped package and told they could open it as soon as they finished a puzzle. After the puzzle was completed, the experimenter busied herself with paperwork for 90s before telling the child they could have the present. A delay score represented a composite of the following behaviours: a) the amount of time that elapsed after finishing the puzzle before the child took the present, b) the number of verbal utterances the

child made about the present during the task, c) the number of physical behaviours directed towards the present, and d) the delay until they opened the present.

In the resistance to temptation situation the children were brought into a room and shown a pile of new, attractive toys and a pile of broken, unattractive toys. The experimenter told the child they could play with the unattractive toys, but that she would leave the room and ask if owner of the attractive toys would allow the child to play with them. The experimenter left the room for 6 minutes, and data were collected on how the child interacted with the attractive toys. The children were given a high delay of gratification score if they ignored the toys completely and a low score if the child picked up the toys and played with them.

A composite score of the children's behaviours in both tasks was determined and correlated with intelligence measures and personality assessments carried out by the child's teachers at 3-, 4-, 7-, and 11-years-old.

Funder et al. (1983) found gender differences in the personality traits that correlated with the delay of gratification score. Girls who delayed gratification for longer were found to be more intelligent, competent, resourceful, and less likely to to be easily offended, to go to pieces under stress, or be victimised by their peers than girls with low delay of gratification scores. These traits were stable across all the ages tested. Boys with high delay of gratification scores were likely to rated as being more reflective, deliberate, dependable, and having better attention spans and concentration than their peers with low delay scores. The boys

with low scores were judged to be more restless and fidgety, aggressive, irritable, unstable, and emotionally expressive. Again, these traits were stable at all ages tested.

Funder et al. (1983) found that the delay of gratification score correlated moderately with only 1 out of 3 intelligence tests for girls, none of the 3 tests significantly correlated with the boy's delay of gratification scores.

These data suggest that children's success on a delay of gratification task is correlated with confidence, academic achievement, and social ease (Funder et al., 1988; Mischel et al. 1988; Shoda et al., 1990). Children's performance on delay of gratification tasks may discriminate between those who show impulsiveness and self-control in other situations: "different measures of delay of gratification can predict, not only different, but contrasting personality qualities depending on the meaning of the particular situation." (Mischel et al., 1988, pg 695)

Correlates Between a Preference for Delayed Reward and Intelligence

Several studies have sought a link between intelligence and a preference for delayed rewards. Schwarz et al. (1983) did not find a significant correlation between IQ and a preference for delayed rewards in 3- to 5- year-olds. Funder et al. (1983) did not find that a delay of gratification score correlated with intelligence in 3- year-old boys, and only 1 out 3 intelligence tests correlated with the delay score of 3- year-old girls. However, it is possible that such a correlation cannot be found

in such young children; as young children are not yet knowledgeable about delay strategies (Mischel and Mischel, 1983), and therefore their intelligence may not yet interact with their choices.

Mischel and Metzner (1962) gave children between the ages of 6-12 a choice of a small candy bar available immediately, or a larger candy bar available after a delays of 1 day to several weeks. The children were also given IQ tests. They found a highly significant correlations between IQ and a preference for delayed rewards, with the more intelligent children choosing the delayed rewards more often than the children with lower IQ's.

Rogriguez, Mischel, and Shoda (1989) looked at a preference for delayed rewards in 6- and 12- year-old children who were diagnosed with impulsivity-related and adjustment disorders. The children participated in the delay of gratification paradigm (Mischel and Ebbson, 1970). They were shown 1 large pile and 1 small pile of candy they could choose from; they could have the large pile if they waited for the experimenter to return on his own, or the small pile if they summoned him back earlier. They found that the children with a higher verbal-intellectual ability waited longer than children with lower IQ scores, and were better able to focus their attention away from the rewards during the delay period. However, because these data were from an at-risk population of children, it is not known if these results would generalise to a typical population of children.

The results from these studies suggest that a preference for delayed rewards does not correlate with intelligence in 3- 5-year-ols (Funder et al.,

1983; Schwarz et al., 1983), but does with children ages 6- 12-years-old (Mischel and Metzner, 1963; Rodriguez et al., 1989). It is possible that as children get older, the skills associated with higher IQ scores may help them form verbal rules, deploy their attention away from the object they are waiting for, and better endure the delay period.

Children's preferences for delayed rewards can predict other personality characteristics of typical children. A similar line of research has found that a delay of gratification test discriminates between typical children and children who exhibit hyperactivity.

A Preference for Delayed Rewards in at Risk Populations

Several studies have provided compelling evidence that a preference for delayed rewards discriminates between children with hyperactivity and typically developing children. ADHD is a condition affecting between 3-7% of school-aged children (Barkley, 1988). Children who suffer from ADHD have trouble completing schoolwork, sustaining friendships, and following directions. Recent research suggests that ADHD is not simply a disorder of attention, but also a deficit of behavioural inhibition (Barkley, 1997). Children who suffer from ADHD are more likely than their peers to seek immediate gratification, and they have difficulty making choices that will result in long term, rather than short term reinforcement. Individuals with ADHD have difficulty making self-controlled choices.

Barkely (1997) suggests that impulsivity, or a problem with behavioural inhibition is the core deficit in ADHD. He defines behavioural inhibition as: a) the ability to inhibit a prepotent response, or a response for which immediate gratification is available, b) stopping an ongoing response pattern to allow a delay to consider whether to continue responding or not, and c) protecting the delay from distraction. He argues that a weakness of behavioural inhibition results in deficits in self-regulation of affect, reconstitution, and verbal and non-verbal working memory. These deficits manifest in impulsive behaviours. Individuals with ADHD have been found to perform impulsively on a variety of tasks such as the stop paradigm (Schachar, Tannock, & Logan 1993), Matching Familiar Figures (Kagan, 1965); and Stroop Tasks (Barkely, Grodzinsky & DuPaul, 1992). These literatures are extensive, and none of the tests mentioned above measure a child's choice or preference for delayed rewards. Instead, they measure a child's reaction times or their ability to stop a response. In the stop signal paradigm the children make a repetitive motor movement in response to a set stimuli, and are asked to quickly inhibit that movement when the stimuli changes. In the Matching Familiar Figures task, the children are asked to choose two matching figures from an array of similar images. They must take their time to carefully examine the image detail, and inhibit making a hasty decision. Although these are important features that distinguish children with ADHD from their peers, the current review is focused on research that studies children's preference for larger, delayed rewards. It is the children's choices, rather than their motor skills that are relevant to the research presented later.

Like the research on typical children, much of the choice research with ADHD subjects has utilised a discrete trail methodology to manipulate the amount of reward with delay. In this paradigm, the child is given a choice between a small amount of a reward immediately, or a larger amount after a short delay.

Schweitzer and Sulzer-Azaroff (1995) hypothesised that a novel situation or distractions during the delay period may increase a preference for delayed rewards in children with ADHD. Ten boys with ADHD and 8 typical boys participated in the research. The children were asked to choose between receiving 1 coin immediately or 3 coins after a 16 second delay. They made their choices by pulling a lever on an apparatus that dispensed the coins. After the session was over, the children exchanged the coins for toys. The delay after each trial was randomised to ensure that the children were not selecting the non-delayed reward in order to finish the experiment sooner. The experimental sessions were broken into two parts, the first condition involved 4 forced-choice trials and 16 choice trials in an empty room. The second condition involved the same type of trials, but distracter toys were in the room for the child to play with.

The typical children were more likely than the ADHD children to choose the larger delayed reward, and showed a increasing preference for the delayed reward across sessions. The children with ADHD also chose the delayed reward, but only slightly more than half of the time. They were more likely to choose the delayed reward during the first day than on the second day of testing, suggesting that they were more likely to prefer delayed rewards in a novel situation. Having toys in the room to

play with did not affect the children's choices. Schwietzer and Sulzer-Azaroff (1995) suggested that the children with ADHD satiated on the reinforcer more quickly than their typical peers, and were not as motivated to wait for three coins after they had experienced many trials. In addition, the authors claimed that children with ADHD discount any delayed reward. These results show children with ADHD making fewer self-controlled choices than their peers, but it should be noted that all of the children made more self-controlled than impulsive choices.

Sonuga-Barke and colleagues argued that that children with ADHD are not impulsive but are delay adverse (Sonuga-Barke, Taylor, Sembi & Smith, 1992a; Sonuga-Barke, Taylor, & Haptinstall, 1992b.) Six- and seven-year-old boys participated in their first experiment, half of boys in the sample exhibited pervasive hyperactivity and the remaining boys were developing typically. The children were given a choice between receiving 1 point after a delay of 2 seconds, or 2 points after a delay of 30 seconds. The points were exchangeable for money at the end of the session. The session continued until the children earned 30 points.

The children participated in 2 conditions in this experiment. In the no post delay condition each trial began as soon as the rewards were dispensed from the previous trial. The children could earn the most points quickly by always choosing the smaller reward. During the no post delay condition both groups preferred the immediate reward. In the post delay condition, one trial started 32 seconds after the beginning of the previous trial; if the child chose the delayed reward he would wait 30s for the rewards, and an additional 2s until the start of the next trial. If he chose

the immediate reward, he would wait 2s for the reward to be dispensed and another 30s for the next trial to begin. The children could earn the most points quickly by choosing the larger, delayed reward. In the post delay condition, both the hyperactive and control groups preferred to wait for the larger reward.

In a second experiment, Sonuga-Barke et al. (1992a) placed time or trial constraints on the sessions. There was no post delay in either condition. In the time constraint condition, the children were told they would have 10 minutes to earn money. In this condition, the children could earn the most points by choosing the larger reward for every trial. Both the hyperactive and control groups preferred the smaller reward in the time constraint condition. In the trial constraint condition the children were told the game would last for 20 trials; the strategy to earn the most points in the trial condition was to always choose the larger, delayed reward. In this condition the hyperactive children chose the large delayed reward 18% of the time, significantly less that control group who chose it 48% of the time.

Sonuga-Barke et al. (1992a) argued that hyperactive children are delay adverse rather than impulsive. Impulsivity has been defined as a preference for smaller, immediate rewards over larger, delayed rewards (Ainslie, 1974, Rachlin and Green, 1974). If the children were impulsive, they would always choose the immediate rewards under all circumstances, if they were delay adverse, they would only choose the immediate reward if doing so decreased the total amount of delay time.

In the post delay condition both groups of children preferred to wait for the larger reward, suggesting that they are not impulsive. However, in the trial constraint condition the hyperactive children preferred the smaller, immediate reward and failed to maximise the total number of points for the entire session. Sonuga-Barke et al. (1992a) suggested that children with hyperactivity are averse to delay; in the post delay condition when they were forced to endure 32 seconds of delay regardless of their choice, the hyperactive children preferred the larger, delayed reward. In trial constraint condition, they chose to avoid both pre- and post-reinforcer delay by selecting the smaller, immediate reward.

Sonuga-Barke (1992a) offers compelling evidence that hyperactive children did not choose the immediate reward because they wanted to minimise the time between choosing and receiving the reward, but because they wished to minimise the total delay. He argued that the delay aversion that underlies children with ADHD's preference for smaller, immediate rewards is functionally equivalent to the hyperactivity and inattention they exhibit at home and in the classroom. The subjective delay can be minimised by engaging in motor activity or by seeking attention from others. When children with ADHD are moving about the classroom or daydreaming, they are engaged in a behaviour that will help pass the time more quickly. (Solanto et al, 2001; Sonuga-Barke, 1994)

Solanto et al. (2001) tested this hypothesis and found that a preference for small, immediate rewards correlates with classroom behaviour in children with ADHD. Seventy-seven children between the ages of 7- and 9-years old who had a diagnosis of ADHD participated in

the experimental group. A total of 29 children participated in the control group. The participants completed a delay aversion task, where they chose between receiving 1 point after 2s, or 2 points after 30s. The children were told before the start of the session that they would have 20 trials. There was no post-reinforcer delay.

In addition to the delay task, the children all participated on a stop signal task. In a stop signal task an individual is presented with two unique stimuli and is required to make a unique response that corresponds to the presentation of each stimuli. For example, the children might be shown either an "X" or an "O" and be required to press the appropriate key on a keyboard. One stimulus is designated a primary stimulus and is typically repeated, causing the child to perform the same behaviour many times in a row. When the other stimulus is shown, the child must inhibit the previous response and execute the new response. Children with ADHD are less likely to inhibit the primary response than their peers (Logan, Cowan, & Davis, 1984; Logan & Cowan, 1984).

The children with ADHD were observed in the classroom for a total of 16 minutes, and data were collected on their gross motor behaviour, time spent off task, and interfering behaviours such as interrupting the teacher or other students. Their parents and teachers completed questionnaires about their levels hyperactivity and impulsivity.

Solanto et al. (2001) found that both the delay task and the stop signal task discriminated between the children with ADHD and the control group. The children with ADHD chose the smaller, immediate

reward more often than their peers during the delay task and made more mistakes during the stop signal task. Their choices on the delay task correlated inversely with parent and teacher ratings of impulsivity, teacher ratings of hyperactivity, and with the direct measures of gross motor activity, off task, and interference behaviours. The stop signal task only showed a significant correlation with direct measures of interference behaviours and aggression. The authors suggested that the delay task "may be of more general significance" (Solanto et al., 2001, pg 225) than the stop signal task.

Rapport, Tucker, DuPaul, Merlo, and Stoner (1986) studied 16 boys with ADHD and 16 typical children in a study of self-control. The children were between the ages of 6- and 8- years-old. They were given a choice between completing 0 or 5 math problems to receive a small number of toys, or completing 15 or 20 toys to receive more toys. In one condition, all of the rewards were given immediately after the problems were completed. In the second condition, the rewards were given immediately if the child chose to complete 0 or 5 problems, or after a two day delay if they chose 15 or 20 problems. The authors hypothesised that children may have an easier time delaying gratification if they have a task to complete during the wait. The children with ADHD were more likely than their peers to choose to complete fewer problems in the delayed condition. However, during the non-delayed condition both groups of children chose to complete more problems for a greater number of rewards. In this paradigm, the children with ADHD showed intolerance to delay, but not to effort.

The research with ADHD children suggests that they are more likely to prefer smaller, immediate rewards in a laboratory test of self-control than their peers.

Training Studies with Children with ADHD

A number of studies have found that children with ADHD can be taught to wait for delayed rewards; but their initial preference if for smaller, immediate rewards. Schweitzer and Sulzer-Azaroff (1988) taught children to gradually extend the amount of time they would wait for a reward in a self-control paradigm. The subjects were six 3- to- 5-year-olds who had been identified by their classroom teacher as showing some form of impulsive or hyperactive behaviour. These children were asked to choose between a small reward (1 sticker) immediately, or a larger reward (3 stickers) after a delay of 0 to 90 seconds.

During the initial baseline, children chose the immediate reward more often than they chose to wait for the larger reward. The experimenter then offered both rewards to the children with no delay, and the children chose the larger reward 100% of the time. Once it was established that the children preferred the larger reward, the length of the delay was slowly increased. The inter-trial intervals were adjusted so the length of the session was equally long regardless of the choices the child made, thereby decreasing the possibility that the children were selecting the immediate reward to end the session more quickly. The children showed an increased tolerance to the delay, and during the post-test chose

the larger, delayed reward more often than the smaller, immediate reward.

Binder, Dixon, and Ghezzi (2000) further explored the factors that help children diagnosed with ADHD make more self-controlled choices. Their subjects were three children between the ages of 3- and 5-years who had a diagnosis of ADHD. The experimenter initially gave each child a choice between one small piece of preferred food or a slightly larger piece of the same food. When the children chose the larger piece, they were asked to wait as long as they could before eating the food. This time was taken as the natural baseline as how long the child could delay consumption of the food. The food remained in the child's view while they were waiting.

During the training phase, the children were given a choice between the two items. If they chose the larger item, they were given one of two tasks to complete while they waited. In one condition, the children engaged in a game with the experimenter, in the other condition they verbally recited a rule such as "If I wait a little longer, I will get the bigger one." The length of the delay was increased by 2 to 3 seconds every session; a session consisted of one trial. Binder et al. (2000) found that the children were more likely to choose the larger delayed item after the self-control training, and there was no effect of the type of task the child performed during the delay. The children did not know how long the delay would be when they chose the larger item. This research extends the findings of Schweitzer and Sulzer-Azaroff (1988) that children can learn to make more self-controlled choices in a laboratory context.

A concern about Binder et al.'s (2000) findings is the method used for determining the baseline delay. The children were asked to "wait as long as they could" before receiving the reward: when they said they could not wait any longer they were allowed to consume the food. There was no incentive for the children to wait very long, and it is possible they stated they were done waiting before their real threshold. The tolerance they showed to the increasing delays during the training phase may have been within the delay they may have tolerated without the training. A second concern is that the delay period was confounded with adult attention. During the delay, the child could play a game with the experimenter, or recite a phrase while the experimenter watched. It is possible that attention was more reinforcing than the food, and by choosing the delayed reward the child was really choosing attention.

These findings (Binder et al., 2001; Schweitzer and Sulzer-Azaroff, 1988) confirm that hyperactive children have a preference for smaller, immediate rewards over larger, more delayed rewards, but that they may be able to reverse this preference with training.

Conclusion

These studies support the claim that children's preference for delayed rewards is a characteristic that is linked to other personality traits such as academic and social competence (Mischel et al., 1988), concentration and performance on standardised tests (Shoda et al., 1990), resourcefulness, dependability, and increased attention spans (Funder et

al., 1983), intelligence (Mischel and Metzner, 1963; Rodriguez et al., 1989), and hyperactivity and impulsivity (Binder et al., 2001; Rapport el al., 1986; Schweitzer and Sulzer-Azaroff, 1988, 1995; Solanto et al., 2001; and Sonuga-Barke et al., 1992a, 1992b).

The delay task discriminates most reliably between children with ADHD and typically developing children. Numerous studies have drawn the same conclusions, leading some researchers to suggest that a preference for smaller, immediate rewards or a delay aversion is the underlying pathology in ADHD (Barkley, 1997; Sonuga-Barke, 1994; Sonuga-Barke et al., 1992)

The other studies reviewed have found that a preference for delayed rewards is correlated with, or predicts personality traits such as academic and social competence. These studies did not ask if the delay task can reliably discriminate between young children with different intellectual or social abilities. Furthermore, none of these effects have been considered developmentally. It is possible that a preference for delayed rewards correlates with certain skills in very young children, but that these differences in skills become less relevant to self-control as a child becomes older.

These data suggest do that a preference for delayed rewards may be a skill or trait that comes more easily to some children than to others. It is not clear from the data if this preference is an innate ability, a product of learning, or a combination of the two. It is interesting to note that different tasks have been correlated with different abilities; Mischel et al. (1988) found that the delay of gratification task correlated with academic and

social competence in adolescence, and Solanto et al. (2001) suggested that children's responses on the delay task corresponds to the classroom behaviour in children with ADHD. This work furthers Mischel et al.'s (1988) claim that "different measures of delay of gratification can predict not only different but contrasting personal qualities..." (695).

Chapter 4
Rationale for Study

The literature reviewed in Chapters 1-3 reveals that the study of children's preferences for delayed rewards is not fully understood. The present studies have been designed to answer the following questions: a.) Do children discount the value of delayed rewards?, b) Does children's preference for delayed rewards increase as they get older?, c) Are there gender differences in children's preferences for delayed rewards?, d) Are children who are categorised as hyperactive by their parents and teachers more inclined to prefer smaller, immediate rewards than their peers? and e.) Does a preference for delayed rewards correspond to other behaviours, such as children's behaviour in the classroom?

This work presents 3 studies that have been designed to help answer these question. The design and rational for these studies will be discussed below.

Study 1

Background

The first study investigates 3- to 5-year-old children's preference for delayed rewards. Previous research has been equivocal with regards to young children's sensitivity to delay and amount, if they discount the value of delayed rewards, and if there is a point when they are indifferent to smaller, sooner or larger, later alternatives. The current study seeks to answer these questions.

Mischel and colleagues found that 3- and 4-year-old children will wait up to 20 minutes for a larger, delayed reward when the rewards were not in view during the waiting period (Mischel and Ebbson, 1970), if they could view pictures of the rewards while waiting (Mischel and Moore, 1973, 1980), when they were told to think happy thoughts, or thoughts about things other than the consummatory properties of the rewards (Mischel and Baker, 1975). When these conditions were not met, the children chose not to wait and accepted a smaller, immediate reward.

As discussed in Chapter 2, Mischel and colleagues used a one trial delay of gratification paradigm. The experimenter showed the children a small amount of a food and a larger amount of the same food. He told the child that he needed to leave the room, if the child waited until he returned on his own she could have the larger reward, if she called him back to the room earlier, she could have the smaller reward. The experimenter left the room for 15- 20 minutes; the child did not know how long the delay would be. There was only 1 trial.

In this paradigm, the rewards were identified and given during a social interaction between the child and experimenter, it is possible that the measure was reactive and the children were responding the way they thought would reflect best upon themselves. The children who participated in the favourable waiting conditions chose to wait once, but may not have made the same choice repeatedly. Furthermore, the children did not know how long they needed to wait for the larger, delayed reward. They did not choose in advance to wait 15 – 20 minutes for the delayed reward, instead they chose from moment to moment not to call

the experimenter back into the room. The results from the delay of gratification paradigm do not provide a record of children's preferences for immediate or delayed rewards, instead the data tell us the conditions that make waiting for delayed rewards easier for children.

A discrete trial procedure provides a more accurate account of children's preferences for larger, delayed rewards. In a discrete trial experiment, the child chooses repeatedly between a small reward available immediately, or a larger reward available after a short delay. Before they are allowed to choose the children must participate in no-choice trials during which they experience both short and long delays and their contingent rewards; during the choice trials the delays are always the same. Because they have experienced and can predict the delays, the children are making an informed choice of whether to wait or not. As there are many trials, they can choose to wait a proportion of the time, which may be a good indicator of their preference.

The discrete trial studies conducted to date suggest that 3-to 5-year-old children are indifferent, impulsive, or insensitive to the amount and delay of rewards. However, all of these studies have methodological limitations.

Logue and colleagues (Logue and Chavarro, 1992; Logue et al., 1996) presented children with a choice to open a drawer and receive 1 reward after a few seconds or open an adjacent drawer and receive 3 rewards after delays of 15- or 30-seconds. The drawer associated with each contingency remained the same throughout the session. The children experienced 4 no-choice trials during which they could open only the left

or right drawer receive the its contingent reward, both drawers were available twice. The left and right drawer were available in alternating sequence during the no choice trials. The girl participants continued to show the alternating response pattern during the choice trials, which led the authors to conclude that they were indifferent between the two alternatives. It is possible that the children may have had a preference for larger, delayed or smaller, sooner rewards, but formed a rule during the no choice trials that the proper way to respond during the experimental session was to select alternating drawers.

Sonuga-Barke et al. (1989a) presented 4-year-olds with a choice to receive 1 token after a delay of 10s, or 2 tokens after delays of 20, 30, 40, or 50s. The tokens were exchangeable for rewards at the end of the session. During these sessions, there was no post-reinforcer delay, one trial started as soon as the tokens were dispensed from the previous trial. The sessions lasted 15 minutes; there was not a fixed number of trials. The way to earn the most tokens in this procedure was to choose the delayed rewards when the larger rewards were available after short delays, and the immediate rewards when the delays to the larger rewards were longer. The 4-year-olds in this study were either indifferent to the alternatives or preferred the smaller, immediate reward; the authors concluded that they were insensitive to amount and delay. The apparatus and stimuli remained the same between sessions, even when the length of delay changed, which may have made it more difficult for the children to notice the changes in delay time and respond accordingly. Furthermore, the rewards were tokens exchangeable for toys or sweets at the end of the

session. As Hyten et al. (1994) point out, this is an extra level of delay to receiving the rewards. It is possible that the young children in Sonuga-Barke's et al.'s study chose impulsively because they had trouble bridging the delay between receiving the tokens and exchanging them for rewards.

The authors of these studies concluded that 3- and 4- year-old children are insensitive to delay and amount (Logue and Chavarro, 1992; Logue et al., 1996; Sonuga-Barke et al., 1989a). The children in these studies were indifferent between a small reward available after a short delay, or a larger reward that were available after delays between 15-50 seconds. Perhaps the children would shift to a preference for the smaller reward if the delay to the larger reward was longer. Temporal discounting theory states that individuals discount the value of delayed rewards as the delay increases; it is possible that young children do discount the value of delayed rewards but the delay times used in these studies were not long enough to be sensitive to this discounting. If children do discount larger rewards as the delay to receiving the rewards becomes longer, it will indicate that they are sensitive to delay. Study 1 will test if 3- 5 year-old children discount the value of delayed rewards

Design

Study 1 is a computer based test of a preference for delayed rewards in young children. The children will choose to receive 1 sticker after 5s, or 3 stickers after delays of 5s-180s. A computerised test has many advantages over the manual apparatuses used in previous studies. On a

computerised test, the stimuli can easily be varied across sessions and delay times, to indicate to the children that the delays have changed. The left and right presentation of the stimuli can be alternated during a session to avoid children choosing one stimuli because they have a bias for the left or right side. Children often enjoy working on computers and may be willing to participate in more computerised sessions than they would with a manual apparatus. Furthermore, the computer can store the child's responses, decreasing the chances of experimenter error.

The study will be a single-subject design. It is possible that there is variability in children's preference for delayed rewards that can be obscured in a group design. For example, one child may choose the delayed option 2 out of 8 trials, and a second child may choose the delayed option 6 out of 8 trials. It would be fair to conclude that the first child has a general preference for the immediate reward, whereas the second child has a preference for the delayed reward. However, if their data were averaged together, it would appear that the group of children preferred the delayed reward 4 out of 8 trials and therefore are indifferent to delay. This problem can often be solved by using a large enough sample, however the research question for study 1 is "Are 3- 5 year-old children sensitive to delay and amount, and do they discount the value of delayed rewards?" As children may differ in their sensitivity, we are not interested in how they respond to specific delay times as a group, but rather how they respond to different delay times as individuals. Therefore, a single subject design will be used and the children's responses will be considered individually.

A second reason to use a single subject design is so the children can experience a variety of delay times that are related to their choices. Previous studies have tested participants using pre-determined delay times; Logue and Chavarro (1992) rewarded children with a small reward immediately, or a larger reward after 30 seconds. It is possible that the children were sensitive to delay, but that a delay of only 30 seconds did not measure this sensitivity. The current study will test children on a variety of delay times, and the delay times may vary between individuals. For example, one child may choose delayed rewards at 60s and at 120s, and we would want to test him at 180s to determine if he still prefers the delayed rewards. Another child may choose delayed rewards at 60s but not 120s, and therefore we would want to test him at 90s to pinpoint his cross-over point. A single subject design allows the methodology to be flexible for each child. The data for each child are not being compared to each other, rather each child's data are evaluated in terms of the research question.

In Study 1, children will choose to receive 1 sticker after a delay of 5s, or 3 stickers after longer delays. Each child will experience several levels of delay, and the delay time will be consistent during each session. Data will be collected on the number of self-controlled choices each child makes at each level of delay. Several procedural decisions have been made that distinguish the current study from previous research; these include the presentation of the stimuli, the type of rewards given, and the absence of a post reinforcer delay.

Presentation of Stimuli. Each session will utilise a unique set of stimuli that corresponds to a specific delay period. This is to offer the children additional information about the contingencies varying from session to session, to decrease the likelihood of them making verbal rules about which stimuli they prefer between sessions.

Rewards. The children will be rewarded with stickers at the end of each trial. They will be given paper to put their stickers on, to help provide a consummatory response for the rewards. Stickers were used because a variety of images can be used to conform to each child's preferences, and the children do not need to wait until the end of the session to earn their rewards. Food was not used because guidelines in the nursery forbade the use of food as a reinforcer.

Absence of a post-reinforcer delay. There will not be a post reinforcer delay between trials. Sonuga-Barke et al. (1992) found that utilising a fixed number of trials and no post reinforcer delay discriminated between children with ADHD and their peers. During piloting, we tested children using this procedure both with and without a post-reinforcer delay. When a post-reinforcer delay was used, the children almost always chose the larger, delayed reward. When there was no post-reinforcer delay, the children's responses were more variable. The current studies will use a set number of trials, and no post-reinforcer delay because this may give a better measure of individual variability in the preference for delayed rewards.

Study 2

The second study asks the following research questions: Does children's preference for larger, delayed rewards increase as they get older? Is a preference for delayed rewards a trait that varies by individual and overlaps with other individual traits such as activity levels in the classroom? Or, is a preference for delayed rewards a combination of both, do children generally develop a greater preference for delayed rewards as they get older, but a preference for delayed rewards continues to be related to children's overall levels of activity and attention?

Background

Mischel and Metzner (1963) found that 10-12 year-old children exhibited a greater preference for larger, delayed rewards than younger children. They presented children with a choice of a small piece of chocolate that was available immediately, or a larger piece of chocolate available after delays of 1- 14 days. A limitation of the study was that it was a single trial experiment and therefore may not provide an accurate indication of the children's preference, for the reasons discussed previously. Furthermore, the study was conducted as a face to face interview with by one of two experimenters. It was found that one experimenter received more delayed choices than the other, suggesting that the measure may have been reactive and the children's responses were somewhat related to the personality or expectations of the experimenter. Other studies using a single trial methodology have found

age differences in children (Miller et al., 1978; Toner and Smith, 1977; and Yates et al., 1981).

These studies provide evidence that children's preferences for delayed rewards increase as they get older. Discrete trial studies have failed to find the same results. Sonuga-Barke et al. (1989a, 1989b) found that children's sensitivity to delay and amount improve between the ages of 4- and 12-years-old, but they did not address the question as to whether their preference or tolerance for delayed rewards increases. Logue et al. (1996) found that 5-year-olds waited more often than both 3- and 7-year-olds for a larger, delayed reward. As discussed previously, the pattern of alternating drawers makes the choices of the 3-year-olds difficult to categorise as impulsive, self-controlled, or indifferent. The data from the 7-year-olds were too variable to draw any developmental conclusions. The amount of reward used in Logue's study was small; the children chose between 0.5 or 1.5 pieces of food; that difference may have been so small that the 7-year-olds were not willing to wait for the larger reward. It is also possible that the variability shown between the 7-year-old participants suggests that a preference for delayed rewards is a trait that varies by individuals, and by the age of 7 these individual differences are starting to make themselves known. Darcheville et al. (1992) also found large variability in a preference for delayed rewards in 6- and 7-year-old children.

The literature from children with Attention-Deficit/Hyperactivity Disorder suggests that a preference for delayed rewards is a trait that varies by individual. Numerous studies have found that children with

ADHD make more choices of the smaller, immediate reward than their typically developing peers (Binder et al., 2001; Rapport el al., 1986; Schweitzer and Sulzer-Azaroff, 1988, 1995; Solanto et al., 2001; and Sonuga-Barke et al., 1992a, 1992b).

Solanto et al. (2001) found that these choices correlated with measures of activity and inattention in the classroom. Children who are more active and less attentive in the classroom preferred smaller, immediate rewards. The authors suggest that a preference for delayed rewards is "functionally equivalent" to episodes of inattention and overactivity in the classroom. Both behaviours result from children trying to avoid delay; when they choose the small reward in the delay task they are trying to avoid the delay to receiving the reward, and they fidget and move around the classroom to help pass the time more quickly and reduce perceived delay. Study 2 seeks to determine if the shared variance between these two behaviours is limited to children with clinically significant levels of hyperactivity and inattention, or if it is true of all children. If a relationship is found in typically developing children, it would suggest that a preference for delayed rewards is a trait that varies by individual and is related to other observable behaviours. Classroom behaviour is a direct measure of behaviour and therefore has advantageous over indirect measures of behaviours, such as parent or teacher report. Direct measures of behaviour do not rely on the memory of the informant, nor are they subject to the biases or errors made when one person is called upon to report on the behaviour of another.

Design for Study 2

A group design was utilised because the statistical power that is provided by group averages was needed to draw conclusions about developmental trends. We were interested if children's preference for delayed rewards increases as they get older in the general population, and if these choices correlate with direct measures of classroom behaviour. Because it was group design study, all of the children participated in the same number of sessions at the same level of delay. Children ages 4-, 6-, and 8-years-old participated in the experiment.

As with Study 1, several methodological decisions make this study different from previous work, these involve: the kind and number of sessions the children participated in, the order the sessions were presented, the type and variety of rewards, the task, and the absence of a post reinforcer delay.

Length of Delay and Number of Sessions. Study 2 was a repeated measures design, and each child participated in 3 levels of delay; they chose between a smaller, immediate reward or a larger reward that was available after 30s, 60s, and 120s. A repeated measures design was utilised to determine if children are sensitive to delay and amount, and if younger children discount the value of the delayed rewards at a faster rate than the older children. If so, we would expect to see the younger children to choose the larger, delayed rewards less often when the delays are longer

than when they are short, and the older children to maintain a preference for delayed rewards even when the length of the delay increases.

Repeatedly testing each child also provides an index of how sensitive the measure is. If child chooses mostly delayed rewards when the delay is 120s, we would expect them also to choose mostly delayed rewards when the delay was 30s.

The delay times were selected based on the data from study 1, in which most of the younger children switched their preference to smaller, sooner rewards when the delay reached 120s. Longer delay times were not utilised because the sessions may have lasted longer than was practical. The children were removed from their class to participate in the study, and it was agreed with the school that they would not be removed for longer than 30 minutes. If the longest delay was 180s, and the child always chose the delayed reward, the session could last up to 45 minutes.

Order of the Sessions. The order in which the delay sessions were presented was counterbalanced across the sample. If the delays were presented in ascending sequence the children may have chosen the immediate reward less at the longer delay, not because they did not want to wait, but because they had grown tired of the computer game or the rewards.

Type and Variety of Rewards. The rewards were chosen to remain reinforcing to the children across several sessions. Prior the start of each trial the children could choose from 10 possible rewards: sweets, chocolates, crisps, pencils, crayons, and coins. It was hypothesised that a variety of possible rewards would maintain the children's interest for

longer than a single type of reward. The rewards were presented pictorially on the computer screen, and the child indicated which reward they wanted by clicking the picture with their mouse. The rewards were given to the child at the end of each delay period; they did not need to wait until the end of the session to receive them.

Task. The children were given maths problems to complete in order to earn their rewards. The problems were below grade level and designed to be easy for the children. The children needed to answer the maths problems correctly, or the trial would end without any rewards being dispensed. The math problems were used to keep the children engaged in the task. It was hypothesised that completing maths problems would be more engaging than clicking a shape on the computer screen, and it would make the task seem to more about maths problems than waiting for delayed rewards.

Absence of a Post-Reinforcer Delay. As in Study 1, there was no post-reinforcer delay and a fixed number of trials. The children were told before the start of each session that they had a total of 14 goes. This was to ensure that they understood that the length of the session was determined by a fixed number of trials, and therefore the way to maximise was to always choose the larger rewards.

Classroom Observation. Each child was observed in the classroom for 30 minutes and data were collected on the number of intervals they engaged in gross motor activities, inappropriate use of materials, make inappropriate vocalisations, and fail to pay attention to classroom instruction or their school work. These behaviours were selected because

they were easy to define, and represented the sort of activities that are generally associated with hyperactivity (Barkely, 1998).

Between 8 and 15 children were observed in each classroom, and the observers spent between 5 and 10 hours in the class. The children were observed one at a time, and the children should not have known that they were being observed. It was hypothesised that the children would get used to the experimenters being in the classroom and not adjust their behaviour to be seen in a more favourable way.

Study 3

Background

Solanto et al. (2001) found that classroom behaviour did correlate with delayed choices on a computer task for children with ADHD. ADHD is a childhood disorder characterised by hyperactivity and inattention to a degree that interferes with academic and social success, Barkely (1997) suggested that the core deficit in children with ADHD is self-control; these children are more likely to make impulsive choices. They prefer the immediate gratification provided by constantly changing activities, rather than the long term rewards of paying attention in class or completing their school work. Solanto et al. (2001) concluded that the impulsivity observed on the computer task shared a common variance with the hyperactivity observed in the class. Sonuga-Barke (1994) suggested that a preference for

smaller, immediate rewards over larger, delayed rewards is a manifestation of delay aversion; children with ADHD find delay punishing and will attempt to avoid it.

In Study 2, the classroom behaviour observed in typical children did not correlate with their choices of larger, delayed or smaller, sooner rewards. This may be because the behaviours of typical children are not as extreme as those seen in children with ADHD; perhaps there was not enough variability in the choices or behaviour of the children to reveal a correlation. Or it is possible that the reasons children with ADHD are more active than other children is because of an underlying delay aversion, as suggested by Sonuga-Barke (1994), and therefore we would not expect to see such a relationship between the delay choices and behaviour of children who are not delay averse. A third possibility is that a relationship between delayed choices and classroom behaviour does exist, but the measures used in Study 2 were not valid. If the measures are valid, we would expect to be able use them to replicate the findings of Solanto et al. (2001). A replication would suggest that the measures are valid, but that a relationship between the classroom behaviour and the delay choices of typical children are not related to one another. Study 3 will address these questions by conducting a similar experiment to Study 2 with hyperactive children.

Design

A group design will be used to determine if the Computerised Test of Delay Preference (CTDP) discriminates between hyperactive and typical children, and to test for a relationship between their choices on a delay task and measures of classroom behaviour. A group design was used to draw conclusions about the behaviour of two groups, rather than the behaviour of individuals.

The design of Study 3 is similar to that of Study 2. Methodological decisions were made with regard to the ages and inclusion criteria of the participant's length of delay and the number of sessions, the type and variety of rewards, and the length of the classroom observation.

Age and Inclusion Criteria for Participants. Participants were recruited from awaiting list for the local NHS Child and Adolescent Mental Health Unit. Letters were sent to the parents of children had been referred to the Unit by their GPs for problems with inattention and hyperactivity. Of the parents who responded, those who rated their children above the 86% on the Conners' Parent ADHD Rating Scale (Conners, 1997) were asked to allow their child to participate in the research study.

The children ranged in age from 5- to 9-years-old. There were not enough participants to separate them into different age groups and analyse the data for age effects. Control participants were age and gender matched classmates of the hyperactive children. The control participants were chosen because they exhibited typical attention and concentration.

Length of Delay and Number of Sessions. The children all participated in two session of the computer task. The length of the delay to the larger

reward was 60s for each session. Different session lengths were not used, because previous research has found that hyperactive children change their response patterns after repeated sessions with the same contingencies (Schweitzer and Sulzer-Azaroff, 1995; Solanto et al., 2001). If the children were tested on different delay times their choices may differ not because of changes in the contingencies, but because they were becoming familiar with the task or satiated on the reinforcers.

The delay time of 60s was chosen during piloting because it best discriminated between the hyperactive and control children. At 30s both groups of children were more likely to choose the larger, delayed rewards and at 120s both groups showed a greater preference for the smaller, immediate rewards.

The Type and Variety of Rewards. As in Study 2, the children chose from 10 possible rewards before the start of each trial. The parents of all the participants indicated the type of rewards the children were allowed to receive.

Classroom Observation. In Study 2, each child was observed for 30 minutes. In Study 3 the observation period was expanded to 3 consecutive mornings. This was done in part because the behaviour of hyperactive children can be variable from day to day (Barkley 1988), and it was hoped that 3 days would provide a more accurate record of their behaviour.

Chapter 5
Study 1: Discounting of Delayed Rewards in 3- to 5 –Year-Old Children

Introduction

A number of discrete trial studies have found that children ages 3- and 4-years-old are impulsive or indifferent to the amount and delay of reward. Children in these studies were offered a choice between 1 sticker or bit of food immediately or 3 stickers or bits of food after a delay of 30s (Logue and Charvarro, 1992, Logue et al., 1996), or 1 point after a 10s delay, or 2 points after delays of 20s, 30s, 40s, or 50s (Sonuga-Barke et al., 1989a). The young children in these studies did not show a clear preference for the larger, delayed rewards, prompting the researchers to conclude that they were impulsive or insensitive to delay.

Mischel and colleagues found that children as young as 4-years-old will wait up to 20 minutes for a delayed rewards when the conditions were right (Mischel and Ebbson, 1970; Mischel et al., 1972, Mischel and Moore, 1972, 1973), suggesting the young children may be sensitive to delay and amount. However, the Mischel studies employed a single trial methodology, with may account for the difference in results between the two paradigms, as discussed in Chapter 4.

It is possible that the young children are sensitive to delay, but that the delay times in the discrete trial studies were not varied enough to pick up their sensitivity. Temporal discounting theory states that individuals

discount the value of delayed rewards (Rachlin, 1992). If a child is indifferent to larger, delayed or smaller, sooner rewards when the delay to the large reward is relatively short, such as 30s, it does not necessarily mean that they will continue to be indifferent when the delays become longer.

The current study seeks to employ a more sensitive methodology than has been used in previous studies to determine if young children are sensitive to reward amount and delay. A single subject methodology will be used to determine if children do discount the value of delayed rewards; the children will be exposed to several different levels of delay to investigate how increasing delays affects their preference for larger, delayed or smaller, sooner rewards.

Method

Participants

A total of 8 children participated in the experiment (See Table 5.1 for their ages and sex.) The participants were enrolled at a University run nursery or after school program; informed consent was obtained by sending a letter home to all the parents of children who attended the nursery at least 3 days a week. All of the children were developing normally and spoke fluent English and at least some Welsh. Two participants began but did not complete the experiment; one was

excluded because he was diagnosed with a learning disability, and the second child chose not to participate after 3 sessions.

	Age	Sex
Participant A	5 years 4 months	Male
Participant B	5 years, 2 months	Male
Participant C	4 years 6 months	Female
Participant D	4 years 2 months	Female
Participant E	3 years 9 months	Male
Participant F	3 years 6 months	Female
Participant G	3 years 6 months	Male

Table 5.1: The age and sex of each participant

Setting and Apparatus

The study was run in a quiet room in the nursery. A small table was in the centre of the room, and a computer monitor was placed on the table. To the left and right of the table were two red barriers that prevented children from looking out the windows or in the mirrors during the experiment. A red curtain was strung between the two barriers behind the monitor, shielding a second experimenter who distributed the stickers. The computer program was run on an Apple IMAC.

Procedure

The children were given a choice to receive 1 sticker after a delay of 5 seconds, or 3 stickers after longer delays. Prior to the start of the first experiment the experimenter asked the children if they had any preferences for the stickers. Participant A chose to only receive stickers of bugs, and Participant D preferred to only receive stickers of vehicles, footballs, and Spiderman. The remaining subjects accepted an assortment of stickers.

The procedure was slightly different for Participants A and B, who were 5-years-old and enrolled in an after-school program, than it was for Participants C- G who were enrolled in a day nursery and less than 5-years-old. The procedures for each group of children will be reviewed separately.

Participants A and B

Participants A and B participated in long delay sessions of 5s, 20s, 40s, 60s, 80s, 100s, 120s, 140s, 160s, and 180s presented in a pseudo-random order (See Table 5.2 for the levels of delay and the order they presented to each child.) The smaller reward was always available after a delay of 5s. Only 1 level of long delay was run per session. If, after these 10 sessions, the child had chosen the larger, delayed reward more often than the smaller, immediate reward for all levels of delay, the delays were

increased by 20s intervals, interspersed with shorter delay sessions they had already experienced. This rerunning of delay times ensured that the child did not experience the long delays sequentially, which may have affected their choices.

	Presentation of Delay to the Larger Reward
Participant A	60s, 100s, 5s, 140s, 80s, 20s, 180s, 40s, 160s, 120s, 200s, 5s
Participant B	60s, 100s, 5s, 140s, 80s, 20s, 180s, 40s, 160s, 120s
Participant C	30s, 5s, 60s, 90s, 5s, 120s
Participant D	30s, 5s, 60s, 90s, 5s, 120s, 30s, 150s
Participant E	30s, 5s, 60s, 90s, 5s, 120s, 30s, 150s
Participant F	30s, 5s, 60s, 90s, 30s, 120s
Participant G	30s, 5s, 60s, 90s, 5s, 120s, 30s, 150s

Table 5.2. The length of delays to the larger reward and the order they were presented to each child. Each delay time corresponded to a unique session.

The children were brought into an experimental room every day until the sessions were completed. They were shown a computer screen and a mouse; both children stated that they knew how to use the mouse. They were given the following instructions:

"You can earn stickers by pressing some buttons on the screen. Do you want to try? You will have a total of 12 goes, can you please tell me how many goes you have? (She waited for them to respond, and repeated the instructions and question until they gave her the correct answer.) There will be shapes on the screen. You need to click your mouse on the shapes and you will get some stickers. We can't talk at all once you start the computer game. Would you like to begin?"

The child was given a piece of metallic looking paper to place their stickers on, and then the experimenter sat in a chair behind the child. To earn stickers, the children selected a shape on the computer screen that corresponded to a specific delay. Each delay pair corresponded with two unique shapes and colours, these informed the children that the contingencies were different to ones they had experienced in previous sessions, and prevented them from making verbal rules about which shape or colour they preferred based on their previous experiences (See Table 5.3 for a pairing of stimuli and their corresponding delay times.)

Participants A and B received 4 no choice trials and 8 choice trials. During the no-choice trials, only one shape appeared in the middle of the screen (See Figure 5.1). Each stimuli was presented twice, and the order that the shapes were presented was determined pseudo-randomly. The children clicked the shape with their mouse and then the screen went blank. At the end of the delay period the computer beeped, and an experimenter sitting behind the curtain slid the correct number of stickers to the child. During the choice trials, both stimuli were presented on the screen simultaneously (See Figure 5.2). The side of the screen that the stimuli were presented on was pseudo-random; each shape appeared on the both left and right side of the screen 4 times. After the delay time was over, the computer beeped and the stickers were given to the child.

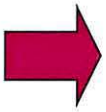
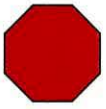
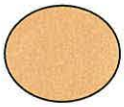
Delay	Immediate Reward	Delayed Reward
5s/5s		
5s/20s		
5s/40s		
5s/60s		
5s/80s		
5s/100s		
5s/120s		
5s/140s		
5s/160s		
5s/180s		
5s/200s		

Table 5.3. A unique pair of stimuli were associated with each level of delay for Participants A and B

There was no post-delay time between trials; one trial started as soon as the stickers from the previous trial had been given. At the end of the session, the experimenter helped the child place their stickers on the paper if they had not done so already, and walked them back to their classroom.

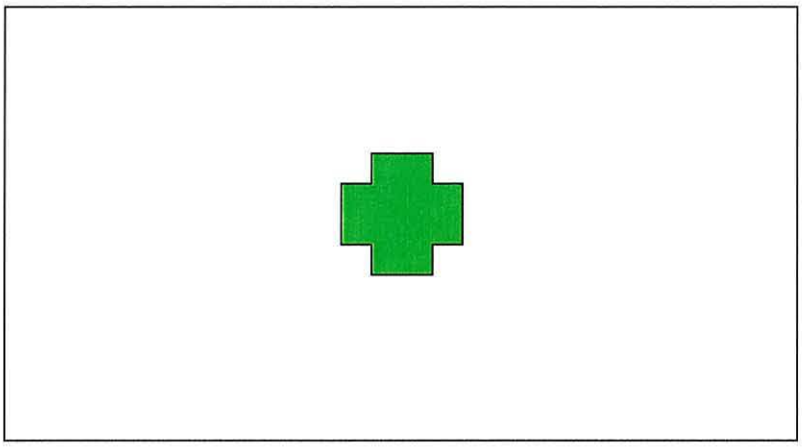


Figure 5.1. During the no-choice trials, only one option was available to the children. The stimuli was placed in the middle of the screen.

Participants C - G

The procedure differed slightly for the younger children. The experiment was presented on a 14" touchscreen rather than on an IMAC computer monitor and mouse, because the younger children sometimes had difficulty moving the mouse. The children were required to touch the shape they preferred.

Pilot data revealed that the younger children had difficulty participating in long sessions, therefore participants C, D, E, F, and G

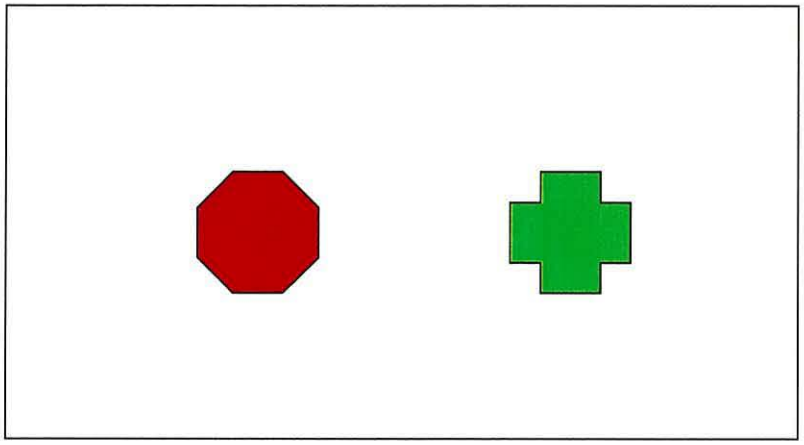


Figure 5.2. During the choice trials, two options were available to the children. The stimuli were placed on the left and right of the screen, and the side that they were presented was counterbalanced across trials.

received 2 no choice trials and 6 choice trials. During the no choice trials only one option was available to the children, in the choice trials both a short delay option and a long delay option were presented simultaneously (See Table 5.4 for a list of the stimuli.)

Participants C, D, E, F, and G were exposed to long delays of 5, 30, and 60s. If the children chose the longer delay at all intervals, the delay was increased by 30 seconds until their preference switched to the immediate reward. The longer delays were interspersed with replications of shorter delay periods to ensure that a child's change in preference from delayed to immediate rewards was not because they were tiring of the experiment or rewards, but because they discounted the value of the more delayed rewards. In all other respects, the procedure was identical to that experienced by Participants A and B.

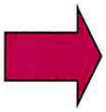
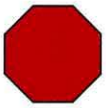
Delay	Immediate Reward	Delayed Reward
5s/5s		
5s/30s		
5s/60s		
5s/90s		
5s/120s		
5s/150s		

Table 5.4. Each pair of shapes corresponded to unique delay times for Participants C, D, E, F, and G.

Results

Figures 5.4 – 5.10 show the number of times each child chose the delayed reward at each level of delay. Occasionally, the children experienced a level of long delay two times. If they chose the same number of larger, delayed rewards during both sessions the data are

represented as a single point on the graph. All of the children showed a decreasing preference for the larger reward as the delay increased. Participant A showed a clear preference for the larger, delayed rewards at delays from 5s to 120s. At 140s he chose indifferently between the two options, i.e. he chose the smaller, immediate reward about the same number of times he chose the larger, delayed reward. When the larger reward was available after delays of 180s, Participant A showed an exclusive preference for the smaller, immediate reward.

Participant B preferred the larger, delayed reward when the delays were between 5s and 60s. His preference for larger, delayed rewards or smaller, immediate rewards varied between 80s and 120s, and he shifted his preference to smaller, immediate rewards when the delays were greater than 140s.

Participants D, E, and F all had a very slight preference for the delayed rewards, or were indifferent of the two alternatives when the delays to the rewards were between 5s and 90s.

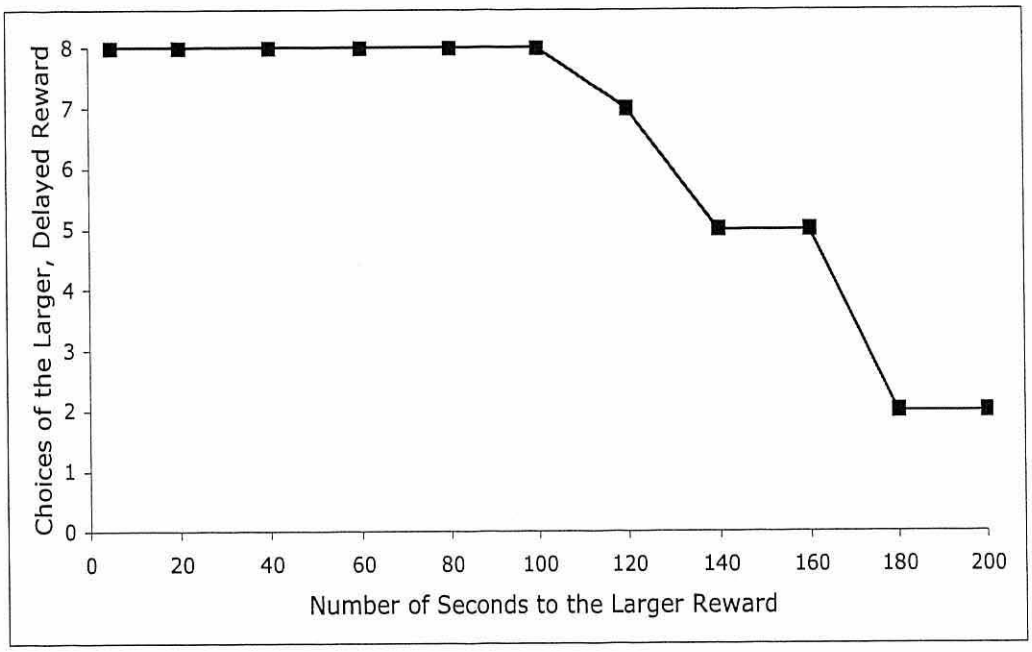


Figure 5.3 The number of trials that Subject A chose the larger, delayed reward for each level of delay.

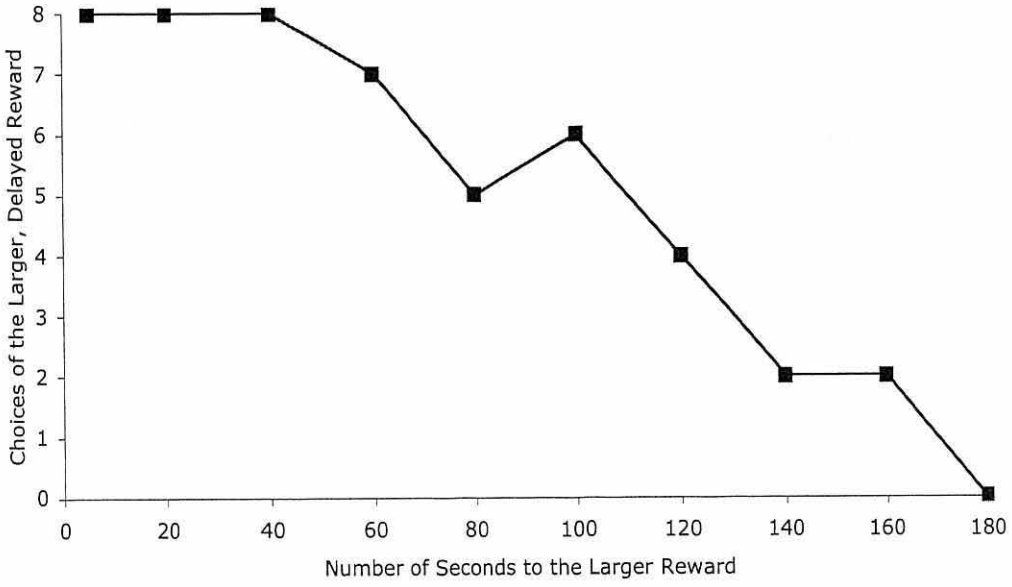


Figure 5.4 The number of trials that Subject B chose the larger, delayed reward for each level of delay

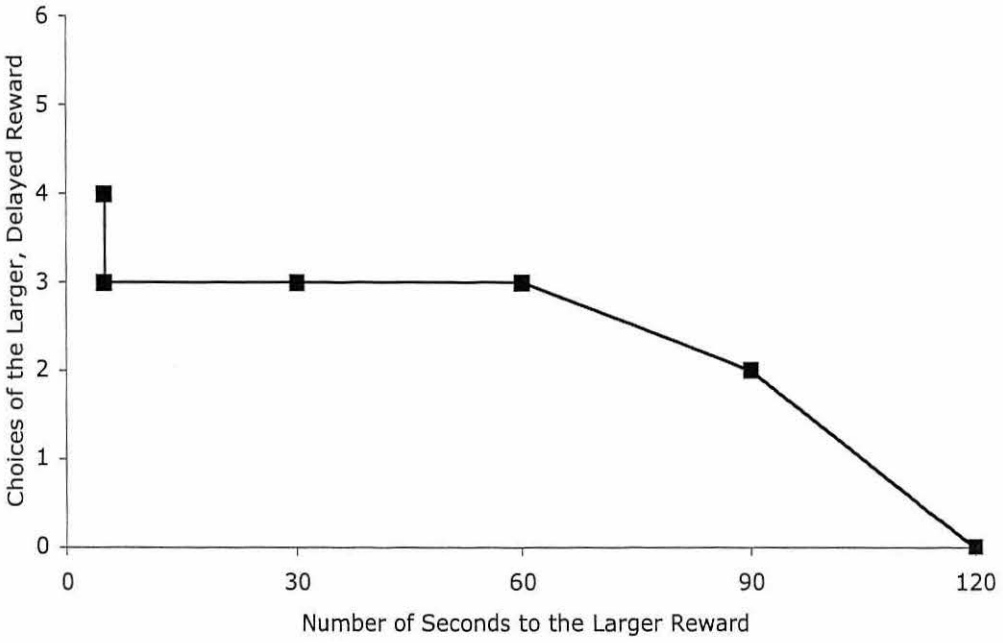


Figure 5.5 The number of trials that Subject C chose the larger, delayed reward for each level of delay.

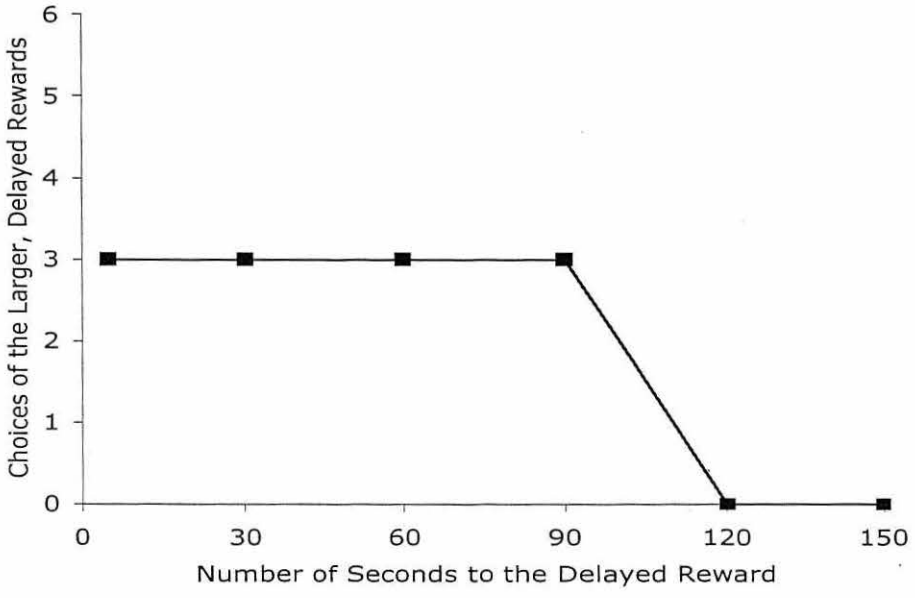


Figure 5.6 The number of trials that Subject D chose the larger, delayed reward for each level of delay.

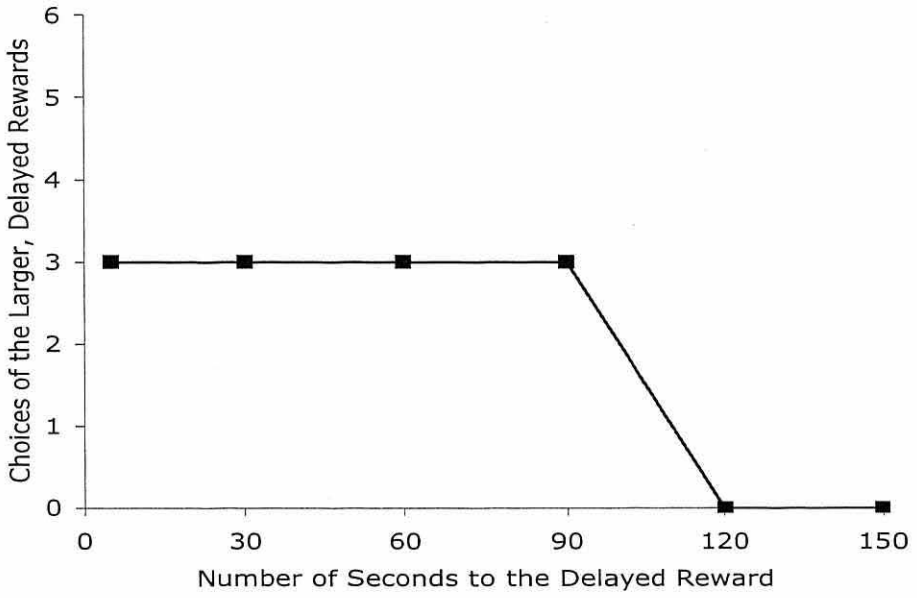


Figure 5.7. The number of trials that Subject E chose the larger, delayed reward for each level of delay.

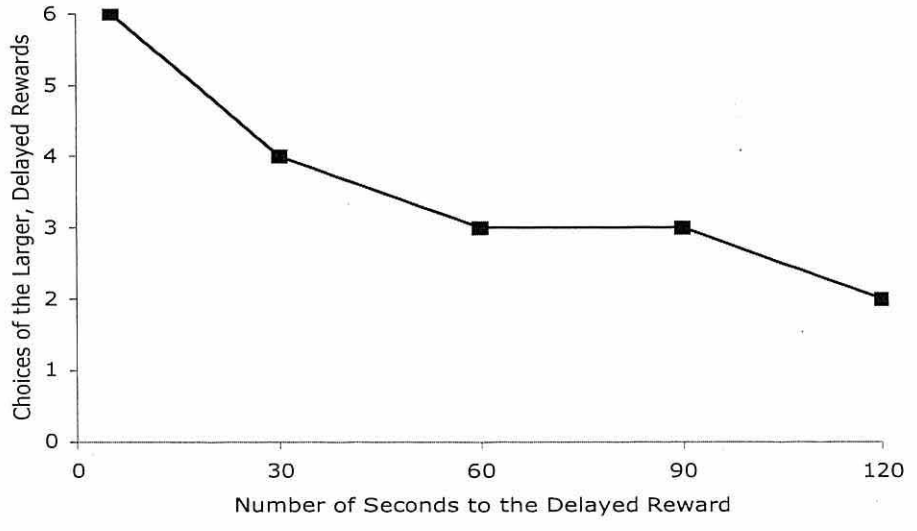


Figure 5.8. The number of trials that Subject F chose the larger, delayed reward for each level of delay.

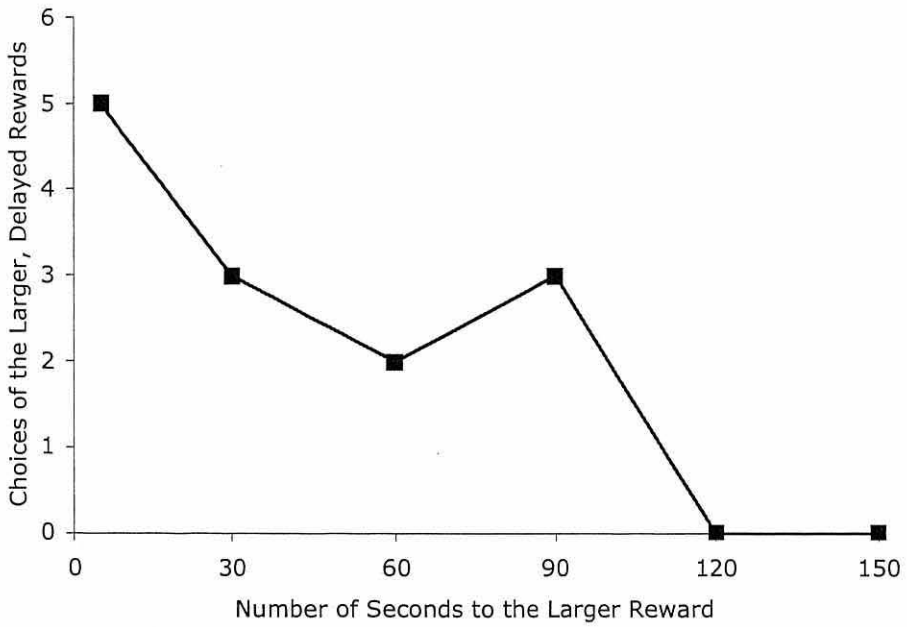


Figure 5.9. The number of trials that Subject G chose the larger, delayed reward for each level of delay.

These three children shifted their preference to smaller, immediate rewards when the delays became greater than 120s or 150s, demonstrating sensitivity to delay when the wait for the larger reward was extended. Participants G and H both preferred the larger rewards when both alternatives were available after a 5s delay, they were both largely indifferent between the two alternatives when the larger reward was available after a delay of 30-90s, and switched their preference to the smaller, immediate reward when the larger rewards were available after delays of 120s.

The child is considered indifferent if they choose each reward alternative equally; if the child chose the delayed alternative between 2-

and 4 times out of 6, they were considered indifferent. It is possible that choosing the delayed option 4 out of 6 times indicated a slight preference for the delayed reward, but it is difficult to draw that conclusion with such a small data set.

Discussion

All of the children who participated in the study showed a decreasing preference for larger, delayed rewards as the delays to the rewards increased. The data from the 5-year-old children (Participants A and B) showed that they preferred to receive 3 rewards when the delays were short, and switched their preference to smaller, immediate rewards as the delay became longer. The delays were not presented in an ascending sequence, so it is unlikely that the children chose the smaller, immediate option because they satiated on the reinforcers or tired of the experimental procedure and simply wanted to end the sessions sooner. The data from the 5-year-olds are consistent with data from Logue et al. (1996) who found that 5-year-old children prefer larger, delayed rewards when the delay was 30s. The 5-year-olds in the current study preferred the larger rewards when the delays were between 5- and 120s.

The data from the younger children were mixed. Two out of 5 of the 3- and 4-year-olds, Participants F and G, showed a clear preference for the larger reward when the delays to the two rewards were equal, were indifferent to the two alternatives when the delays were between 30 and

90s. When the delays were 120s or 150s, the children preferred the smaller, immediate reward over the larger, delayed reward.

Participants C, D, and E never showed a preference for the larger, reward, even when the delays to both options were equal. They switched their responses from indifferent to a preference for smaller, immediate rewards when the delays were 90s or longer for Participants D and E, and 120s or longer for participant E.

The data from the the 3- and 4-year-old children are consistent with the findings of Logue and Chavarro (1992), Logue et al. (1996), and Sonuga-Barke et al. (1989a) who found that 3- and 4-year-old children either choose impulsively or indifferently between larger, delayed rewards and smaller, sooner rewards when the delays were between 0 – 50 seconds. The Logue studies also found that young children do not show a consistent preference for a larger reward when delay was held constant. These data led the authors to conclude that 3- and 4- year-old children are not sensitive to reinforcer amount and delay. Three out of five 3- and 4- year old children in the current study were indifferent between the smaller, sooner and larger, delayed options when the delays to the larger rewards were between 5- and 90s. They did not show sensitivity to delay until the wait was 120s or longer.

The data from the present study suggest that the 5-year-old children are sensitive to delay, as they switched their preference from larger, delayed rewards to smaller, sooner rewards when the delay to the larger rewards increased. Three out of 5 of the children never showed a preference for the larger rewards, suggesting that they have not decided

that "more" is better. They all did show some sensitivity to delay, as they exhibited a clear preference for the smaller, immediate reward when the delays to the larger reward were 120s or longer. Previous studies did not find this sensitivity because they only presented the children with shorter delays.

It is not possible to determine from the present study if the children are sensitive to amount. The children were only offered 1 or 3 stickers, and 3 of the younger children were indifferent between these amounts. If we parametrically varied the amount of stickers the children could receive, while holding delay constant, we could obtain a measure of how children value "more" vs. "less."

Ideally, more sessions should have been conducted for each child, and the younger children should have been exposed to more trials per session. The younger children only participated for 6 trials, and selecting the delayed reward a total of 2, 3, or 4 times was regarded as indifference. If they participated in more trials during each session they may have established a stronger preferences than were seen in the current study. If each session was run more that one time, we would have had a better measure of the reliability of the child's preference for delayed rewards at a particular level of delay. Also, if more sessions were conducted with a greater number of delay times, it may have been possible to define each child's indifference point with more accuracy. The presentation of the stimuli was quite dull, and during piloting it was revealed that the younger children did not want to participate after 2 or 3 weeks of testing.

If the presentation was more interesting, the children may have been able to participate for longer sessions.

The data in this experiment *suggest* that children's preference for delayed rewards increases as they get older. The 5-year-olds in this study maintained a preference for the larger, delayed rewards at much longer delays than the younger children. However, the study was designed to test if young children are sensitive to delay and amount. Each child participated in a several sessions, and they did not all experience the same contingencies. These limitations prevent direct comparisons between the children, especially between the older and younger children.

It is also possible that differences seen in the children's choices of delayed rewards were not a result of developmental changes, but indicative of individual differences between children. Subjects A and B were both 5-year-old boys, but subject A showed an exclusive preference for delayed rewards at delays up to 100s, whereas Subject B started to choose some smaller, immediate rewards when the delays were 60s and higher. Subjects F and G were 3-years-old and showed a greater preference for larger rewards when the delays were equal than 4-year-old Subjects C and D. It is possible that some children may have a greater preference for larger, delayed rewards than others, regardless of their age.

Study 2 utilised a group design procedure to attempt to distinguish between these two hypothesis. The current study found that 4-year-old children may be sensitive to amount and delay, and Study 2 compared their choices on a computerised test of delay preferences to the choices of 6- and 8-year-olds. The current study did not investigate if there were any

effects of gender, therefore the following study used equal numbers of boys and girls and compared their choices. A group design was used to facilitate these comparisons; all of the children participated in the same paradigm and the average number of delayed choices the children made at each age group and of each gender were directly compared to the other age groups and gender.

The children were also observed in the classroom for 30 minutes each and data collected on their activity levels and attention. Solanto et al. (2001) found that high activity levels and poor attention in the classroom negatively correlated with the number of self-control choices children with ADHD made on a computer task. It is possible that a preference for delayed rewards is a trait that varies by individual, and correlates with other unique personality characteristics such as activity level and attention.

Study 2 used a more interesting presentation format, and allowed the children a greater choice of rewards. In the current study only the two stimuli appeared on the screen. The following studies used an interactive computer program, which gave the children auditory and visual feedback on their progress and choices. It was hypothesised that the children might be willing to participate for longer sessions if the computer game is more interesting.

Chapter 6
Study 2: Self-Control in Typically Developing Children: The Effects of Age, Gender, and Individual Differences

Introduction

The data from Study 1 suggested that children's preference for delayed rewards may increase as they get older. It is also possible to interpret the data as suggesting that a preference for larger, delayed rewards (LDR) is a trait that varies by individual. The sample in Study 1 was very small and the methodology did not permit comparisons between children of different ages. The current study seeks to determine if there are age differences in children's preference of larger, delayed rewards in a discrete trial paradigm, and if these differences are related to other behaviours the children exhibit in the classroom. The most effective way to compare differences in age, gender, and classroom behaviour is with a group design study.

Discrete trial studies have so far failed to find clear age differences in children's preference for delayed rewards. Logue et al. (1996) found that 5-year-olds showed a greater preference for LDR than 7-year-olds. Sonuga-Barke et al.(1989a, 1989b) showed that children's sensitivity to delay increases with age, but they did not specifically test the hypothesis that children's preference for delayed rewards also increases with age.

Mischel and Metzner (1962) found that 10-to 12-years-old had a greater preference for LDR than 6-to 9 year-olds; and other studies have found that 7- and 8- year-olds have developed more effective strategies for

waiting than younger children (Miller et al., 1978; Toner and Smith, 1977; Yates et al. 1981). These studies all employed a single trial methodology; the children were offered a choice of a smaller immediate reward or a larger delayed reward only once. In a discrete trial study, the participant is given repeated opportunities to choose between two alternatives, and the additional data may provide a more reliable record of their preferences. A discrete trial study that shows that children's preference for delayed rewards increases with age will offer further evidence that self-control is a skill that develops and improves throughout childhood.

A second hypothesis is that a preference for delayed rewards is a trait that varies by individual. The children in Study 1 showed variability in their preference for delayed rewards, suggesting that some children may simply be better at waiting for larger, delayed rewards than others. Mischel (1984) suggested that children do generally get better at waiting for delayed rewards as they get older, but that some individuals will always be better at waiting than others.

Solanto et al. (2001) found the choices ADHD children made on a discrete trial delay task correlated with inattention and activity levels in the classroom. The children who exhibited high levels of activity in the classroom also preferred smaller, immediate rewards. The authors suggested that the activity and inattention exhibited by children with ADHD is functionally equivalent to their choices of smaller, immediate rewards on a delay task. Both behaviours are motivated by an underlying delay aversion. (Sonuga-Barke, 1994). Activity levels in the classroom may be a good indicator of a person's ability to delay gratification. Often,

in the classroom, children need to turn their attention away from fun tasks such as talking to their friends or playing with objects, and concentrate on their assignments or a teacher's instructions. The children who choose to complete their assigned school work may be rewarded with higher marks of more free time later. Other children have difficulty focusing their attention on school work, and show more activity and inattention in the classroom. The current study seeks to extend this finding and tests the hypothesis that a preference for delayed rewards will correlate with activity levels and attention in the classroom shown by typically developing children.

In Study 2, children ages 4-, 6-, and 8-years-old were given a choice to receive 1 treat immediately or 3 treats after delays of 30, 60, and 120s. All of the children were observed in the classroom for 30 minutes and data were collected on their activity levels and attention. Three competing hypotheses emerge from the research. The first is that the older children will show a greater preference for delayed rewards than the younger children, and no relationship will be found between reward preference and classroom behaviour. The first hypothesis suggests that a preference for LDR is a trait that develops as children get older. The second hypothesis states that no age effects will be found in children's preference for the LDR , but children who show a preference for the smaller, immediate reward will also exhibit higher levels of activity and inattention in the classroom. This would suggest that a preference for LDR is a characteristic that is related to other individual personality traits, such as activity levels in the classroom. The final hypothesis is that both age

differences and correlations between choices on the delay task and classroom behaviour will be found; suggesting that in general children's preference for LDR increases as they get older, but that the trait also varies by individual.

Method

Participants

A total of 72 children participated in this experiment. Twenty-four children participated from each of the following classes: reception (mean age: 4 years, 6 months), year 2 (mean age: 6 years, 7 months), and year 4 (mean age: 8 years, 9 months). Equal numbers of boys and girls participated in each group.

The children all attended local schools in North Wales, and were recruited by a letter and a permission slip which was sent home to the parents of all the children in a classroom. All of the year 2 children and half of the reception children were recruited from an English language school. The year 4 and remaining children from the reception class were recruited from Welsh/ English bilingual schools, all of these children spoke fluent Welsh and English. They were all enrolled in regular education classes and had no known developmental, learning, or behavioural difficulties. As part of the consent form, the parents were asked to select the kind of rewards the children were allowed to receive. If the parents selected fewer than 5 items, the children's data were not included in the final sample. If the children had fewer rewards to choose

from they may have satiated on them more quickly. These children may have chosen the smaller, immediate more than the children with more reward options not because they were averse to delay, but because they had tired of the rewards.

Setting and Apparatus:

The computerised assessment was conducted in an empty classroom or Library on a Toshiba laptop (Satellite 1700) with an external mouse attached. An empty room was chosen to ensure that there was little competing stimuli for the children's attention. If the assessment occurred in a busy environment, the children may have found it easier to wait for the delayed reward because they enjoyed watching an active scene. The computer was placed on a table, and a red curtain was hung behind the computer to shield a second experimenter who dispensed the rewards. There were no clocks or time keeping devices in any of the rooms.

The rewards available to the children were: crayons, coloured pencils, stickers, £.05 coins, grapes, Maltesers, Chocolate Buttons, White Chocolate Buttons, Skittles, and several different flavours of Hula Hoops. The rewards that each child was offered depended on which items their parents had given permission for them to receive.

Procedure

Computerised Test of Delay Preference: The Computerised Test of Delay Preference (CTDP) measured a preference for delayed rewards for each of the participants. Each children participated in 3 levels of delay; they could choose to answer a maths problem and receive 1 treat immediately, or answer the same maths problem and receive 3 treats after delays of 30, 60, or 120s. The children needed to answer the problem correctly to receive the rewards. The amount of delay to the larger reward was consistent during each session, and the order the sessions were presented was counterbalanced across all of the children. Data were collected on the number of delay choices the children made.

Prior to the first session the experimenter took any watches or time keeping devices away from the children so they could not measure time during the delay periods and read the following instructions:

> "Today you can earn some sweets by doing math problems. You will have 14 goes to earn sweets. Can you tell me how many goes you have? (The experimenter waited for the child to respond, and repeated the instructions if he could not answer her correctly). For the first 4 goes you won't get any choices; you should just answer the question on the screen. But after that, that you can choose which problem you want to do, and if you want to work for 1 or 3 treats. You can eat your treats right away or save them for later; it's up to you. To start, you need to listen to the computer program and click the buttons on the screen. I will not be able to talk to you at all once the computer starts. Even if you try to talk to me or ask me questions I won't be able to answer. Are you ready?"

Before the second and third session the experimenter said the to child:

> "This will be just like it was last time, only the amount of time you have to wait for 3 treats will be different. You still have 14 goes, can you tell me how many goes your have?"

The experimenter gave the child some paper and a pencil to assist with the math problems, and a small bag to hold their rewards if they chose to save them. She started the computer program and took out a book to read to further discourage the children from speaking to her.

At the beginning of the computer program, an animated cat welcomed the participant to the game and stated that the purpose of the game was to do math problems to earn sweets. Pictures of the 10 rewards appeared on the top of the screen. If the child's parents only gave permission for the child to receive between 5 – and 9 rewards, some of the items were duplicated. The cat said: "Here are some treats you can work for, press the one you want to work for." (see Figure 6.1 for an illustration of the screen.)

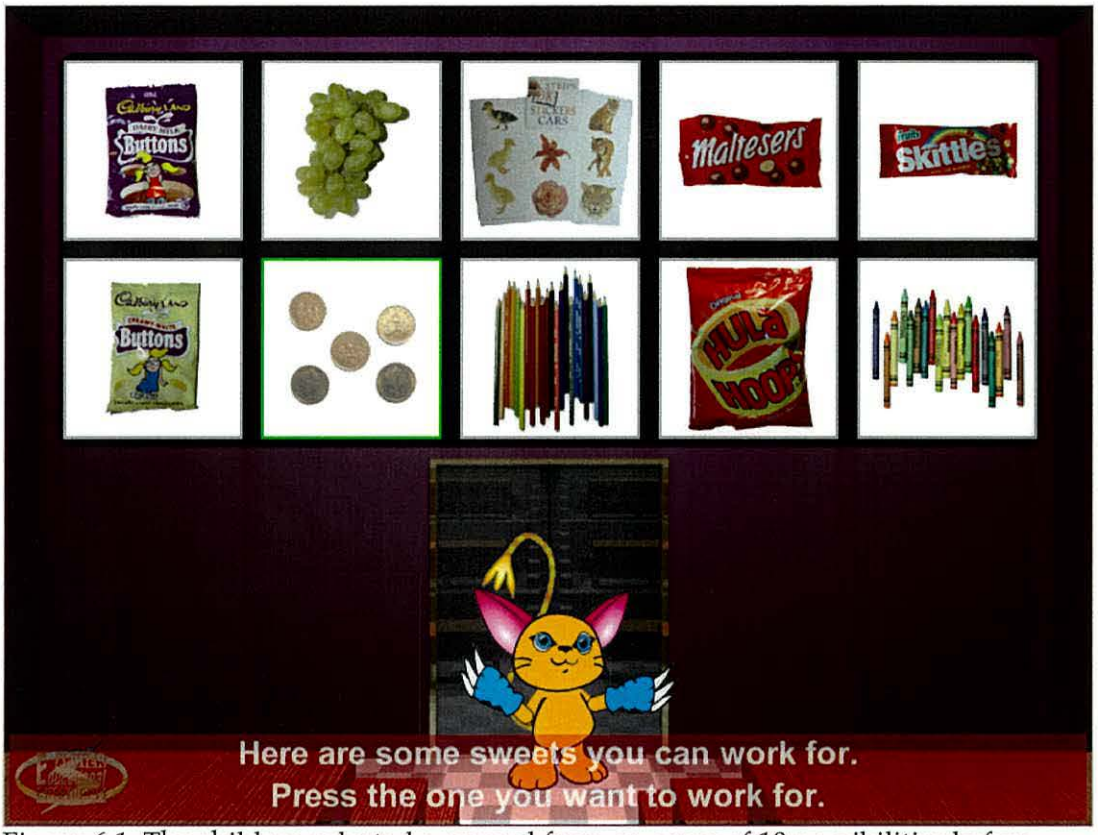


Figure 6.1. The children selected a reward from an array of 10 possibilities before the start of each trial.

After the child selected a reward, two different coloured boxes appeared on the screen. During the 30s delay condition, the immediate choice appeared in light blue box and the delayed choice was dark blue; in the 60s condition the immediate choice was purple and the delayed choice was green, and in the 120s condition the immediate choice was red and the delayed choice was yellow. Above the delayed choice box was a picture of 3 pieces of the chosen reward, and above the immediate choice box was a picture of 1 piece of the same item. The cat said: "If you do the red problem you can 3 of them after you wait a little while, or you can do the yellow problem and get 1 of them right away." (See Figure 6.2.) The screen went blank for 1s, and reappeared with only one problem and its

corresponding reward available on either the left of right side of the screen. (see Figure 6.3). The side the problem appeared was counterbalanced.

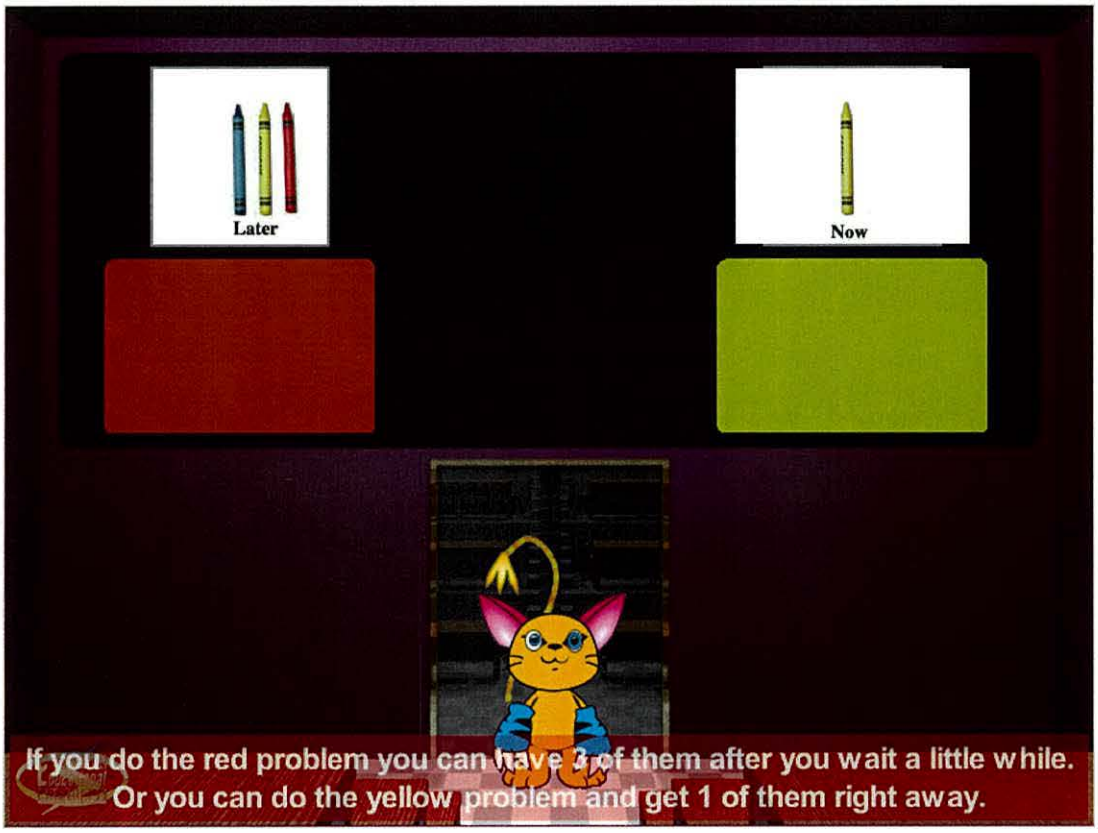


Figure 6.2. The cat explained to the children that they could choose to complete one problem and receive 3 treats after a delay, or select the other box and receive 1 treat immediately. The children could not yet choose which problem to complete.

The maths problems were selected to be easy for the children to complete. The children in the reception classes were shown a number in the problem box and asked to find the number that matched from an array of 3 numbers. The older children were given a problem of single digit addition or subtraction in the problem box, and asked to find the correct answer from an 3 possible choices. None of the children answered more than 3 problems incorrectly during a session.

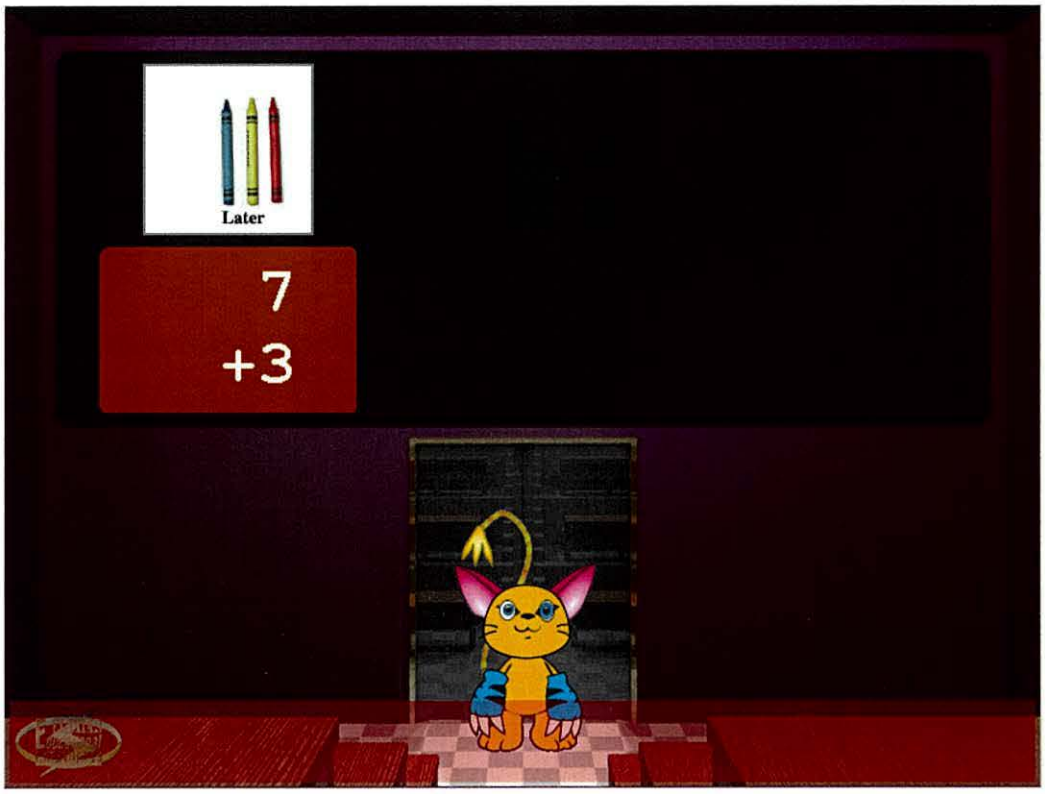


Figure 6.3. At the beginning of a forced choice trial, the child was given 1 problem to solve. This figure shows a trial that will result in a larger, delayed reward. The other trial type was in a different colour box and had a picture of one reward above the problem with the word "now" appearing at the bottom of the box.

The first four trials were no-choice. (i.e., only one of the coloured boxes and its corresponding reward were available on the screen). The child was prompted to click on the problem. On the following screen, the math problem appeared on the top left of the screen, and three possible solutions across the bottom. (see Figure 6.4) If the child selected the correct answer, the cat appeared on the screen and said "That's the right answer, you've earned 3 (or 1) treats. I'll set my clock and as soon as it

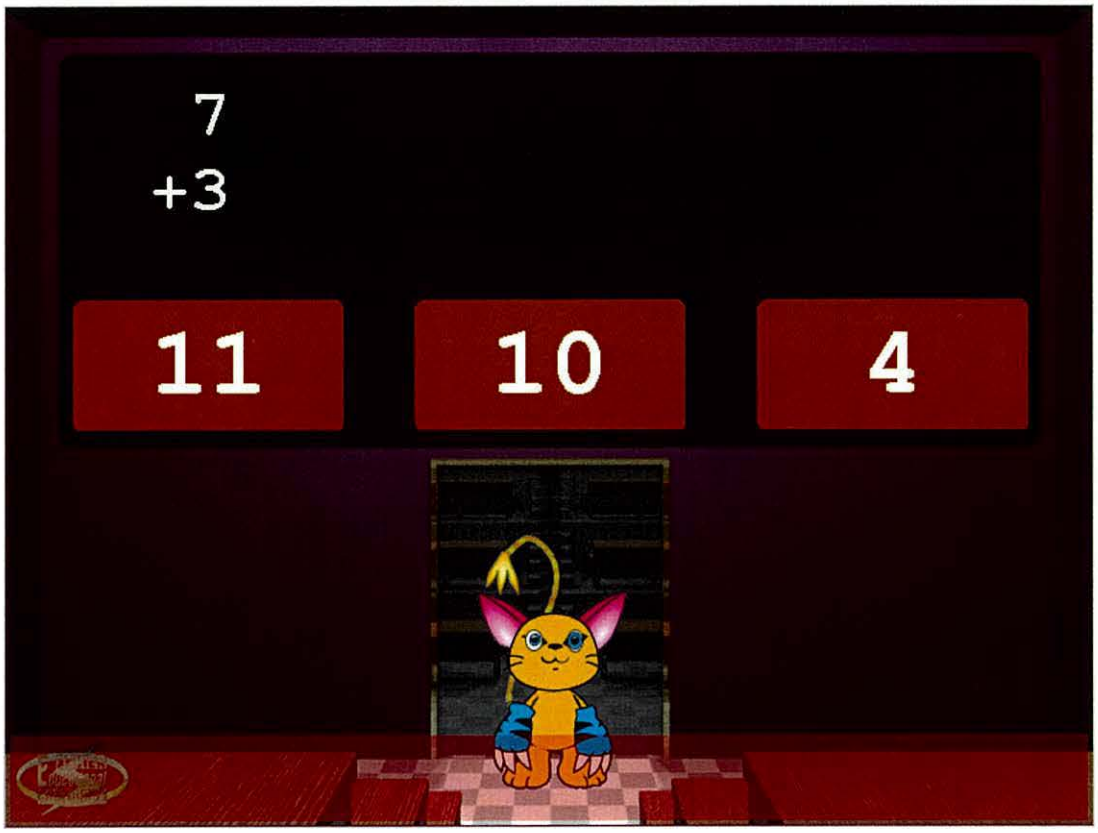


Figure 6.4. The problem was presented to the child with 3 possible answers below. The children were required to select the correct answer.

beeps you can have your treats." The cat looked at a watch on his wrist; nothing on the watch moved and there were no devices to help the children keep track of time. (See Figure 6.5) The computer beeped after the appropriate amount of time, and the second experimenter passed the sweets to the child from under the curtain.

If the child selected an incorrect answer to the problem, the cat appeared on the screen and said: "No, that's not the right answer. Let's do another problem." The children chose a reward from the 10 choices prior to the start of each trial. The order of the problems and side they were presented on was counterbalanced.

Following the no-choice trials were 10 choice trials. The cat prefaced the trials by saying: "Now you can do whatever problem you

Figure 6.5. The cat looked at a watch during the delay period. At the end of the delay period the computer beeped and the rewards were given to the child.

want. Lets begin." The child chose from the rewards before the start of each trial, and the different coloured boxes both appeared on the screen and contained identical math problems. (See Figure 6.6) Following the tenth trial, the cat said: "That's all for today. Good-bye" and the screen went blank.

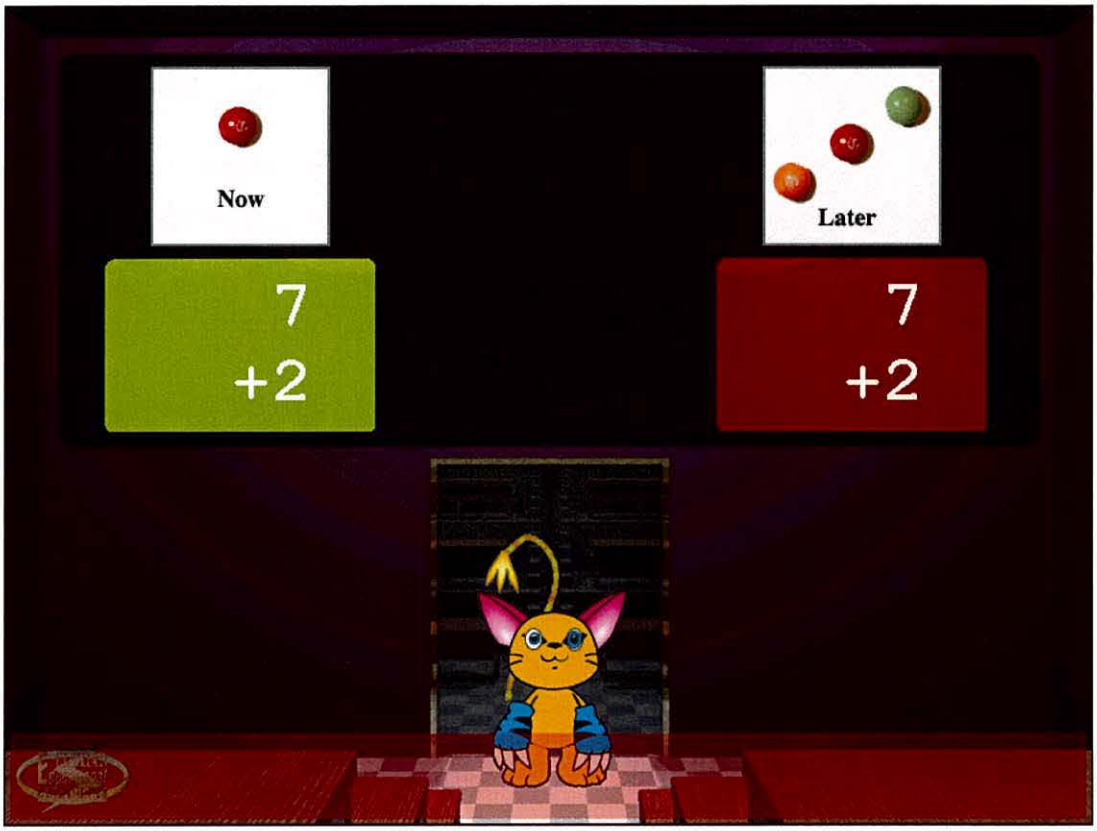


Figure 6.6. During the choice trials the children could choose to do one problem and receive 3 treats after a delay, or complete the other problem and receive 1 treat immediately.

Classroom Behaviour. Data on classroom behaviour were collected for 30 minutes for each child using an audio tape player with headphones. The data were all collected by two trained graduate students in psychology. The graduate students observed the children in the classroom with the primary investigator for 3 hours during piloting. Their agreement with her was over 90%.

The two graduate students coded 100% of the data, and 20% of the sessions were coded by two people. Of this 20%, the graduate students coded 50% of the sessions together, and each coded 25% of the data with trained undergraduate psychology students. The observers sat in a corner

of the room where they could observe the children. The observers listened to an audio tape that counted 10s intervals, and marked on the observation sheet if the behaviour happened anytime during the 10s interval.

Classroom behaviour data were collected between 9:00am-12:00pm. Data were collected only during lesson time, e.g., when the children were assigned seatwork, or the teacher was giving verbal instructions. Data were not collected when the child was receiving 1:1 attention from an adult, during the children's play time, or during classroom transitions.

The following behaviours were recorded using a 10-s partial interval procedure: (a) Gross Motor Activity: any movement of feet across the floor, when the shoulders touched the floor, or when the chair had two feet off the ground; (b) Inattention: engagement in an activity other than the assigned task; (c) Inappropriate use of materials: manipulation of an object in a manner that interfered with completing schoolwork, e.g. making drumming noises with pencils (d). Inappropriate vocalizations: audible speech when the rest of the class was silent, speaking without permission.

Interobserver Agreement. The average total, occurrence, and non-occurrence agreement were calculated for each interval by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100%. The agreement between the two graduate primary observers are reported for all the sessions they coded together, as well as their agreement with the four trained undergraduate students.

(See Table 6.1 for a detailed report of the agreement). Observers were trained undergraduate and graduate students in psychology and total, occurrence, and non-occurrence agreement was over 90% for all behaviours.

	Occurrence Agreement	Non-Occurrence Agreement	Total Agreement
Graduate Student 1 and Graduate Student 2	91.6%	99.5%	99.4%
Graduate Student 1 and Undergraduates	88.9%	96.5%	96.7%
Graduate Student 2 and Undergraduates	94.9%	99.2%	99.3%
Average Agreement	91.8%	98.7%	98.7%

Table 6.1. The average occurrence, non-occurrence, and total agreement for each pair of observers.

Results

The mean number of times the children chose the delayed reward and the standard deviations for each age group at each level of delay are presented in Table 6.2. The 4- and 6-year-olds showed similar pattern of responses at all levels of delay; they showed a preference for the larger,

delayed reward when the delay was 30s, and were indifferent between the two alteranatives when the delay to the larger rewards was 60s or 120s. The 8-year-olds chose the larger, delayed more often than the younger children at all levels of delay. All 3 groups of children chose the larger delayed reward most often at delays of 30s, less when the delay was 60s, and least often when the delay was 120s.

		4-years	6-years	8-years
30s Delay				
Boys	Mean	6.5	7.0	8.8
	S.D.	3.1	2.7	1.8
Girls	Mean	7.8	7.8	8.7
	S.D.	2.6	2.0	2.1
60s Delay				
Boys	Mean	6.0	5.4	8.6
	S.D.	3.8	3.1	2.3
Girls	Mean	6.4	7.1	8.5
	S.D.	3.0	2.7	1.9
30s Delay				
Boys	Mean	5.7	4.3	7.5
	S.D.	3.5	3.0	2.5
Girls	Mean	5.3	6.3	8.1
	S.D.	2.9	3.5	2.5

*$p<.05$

Table 6.2. The mean and standard deviations (S.D.) of the number of times the boys and girls in each age group chose the delayed rewards at each level of delay.

One-sample Kolmogorov-Smirnov tests were run for each age group for each level of delay to determine if the distribution of the data was normal. The data was normally distributed for all the groups, except

for the 8-year-olds KSZ=.296 when the delay was 60s. The means and standard deviations reveal that this was because the data cluster around the highest possible score the distribution is skewed toward the upper range of the data. The data will not be transformed because 7 out of 9 groups did show a normal distribution, and the ANOVA is generally robust against such violations of normality (Glass and Hopkins, 1996).

A repeated measures Analysis of Variance (ANOVA) was run, the between subject factors were age (3 levels) and gender (2 levels), and the within subject factor was the length of delay (3 levels). The Mauchley's Test was conducted to test the assumption of spericity, and was found significant , (W=.75), $p<.001$, indicating that the variance was not equal across all groups at all levels of delay. To correct for this, data were interpreted using the Huynh-Feldt epsilon adjustment to the degrees of freedom. (Glass and Hopkins, 1996).

A main effect was found for the delay to reinforcement $F(2, 132)=13.9$, $p<.001$[1]. These data suggest that the children made significantly more responses of the larger reward when the delay was short than they did when the delay to the reward increased. There were no significant interactions found between delay and sex, delay and group, or between delay, sex, and group.

A main effect was found for group $F(2, 66)=5.997$, $p<.01$ suggesting that the children of different ages responded differently on the task. There

[1] The standard df are reported, however the analysis were conducted using the Huynh-Feldt corrected df which were (1.75, 115.59)

was no main effect of sex, or significant interactions between group and sex, indicating that the boys and girls did not respond differently from each other or show a different pattern of responses at different levels of delay. The children's choices for each group are shown in Figure 6.7

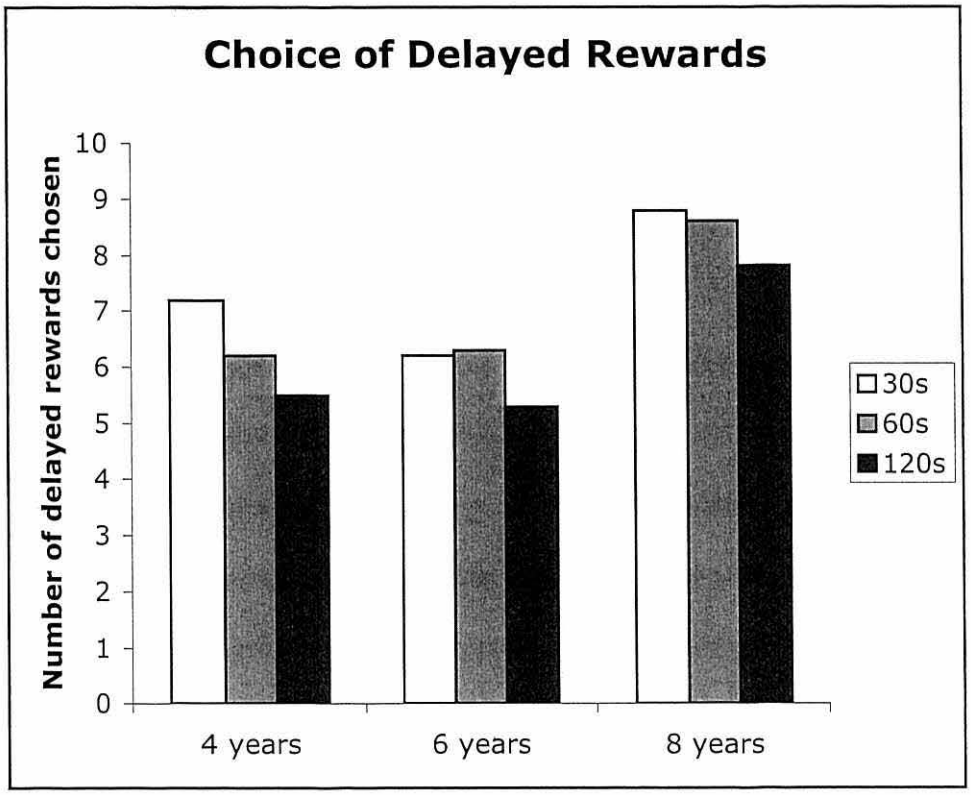


Figure 6.7. The number of choice of the larger, delayed reward made by each age group and all 3 levels of delay.

A Bonferroni test found no difference between the children in reception class and year two (p=1.00); but significant differences were found between children in the year 4 and reception classes (p=.01) and between year 4 and year 2 (p=.01). These data suggest that children's preference for delayed rewards remains constant between ages 4 and 6, but increases between 6 and 8 years of age.

Classroom Behaviour

Table 6.2 shows the means, standard deviations, and tests of normality for each behaviour for each age group. The assumption of normality was met for each condition except for the 8-year-olds inappropriate use of materials. Again, this irregularity will not be corrected because 11 out of 12 conditions met the assumption for normality, and ANOVA is generally robust against such violations of the assumption (Glass and Hopkins, 1996).

	4-year-olds	6-year-olds	8-year-olds
Gross Motor Behaviour			
Mean	6.7	5.3	6.2
Std. Deviation	5.5	5.7	5.35
K-S Z	.795	.862	.754
Inattention			
Mean	12.9	10.8	6.8
Std. Deviation	8.2	9.1	5.6
K-S Z	.886	.814	.760
Inappropriate Use of Materials			
Mean	2.8	.87	1.9
Std. Deviation	3.08	1.4	3.9
K-S Z	.980	1.3	1.8*
Inappropriate Vocalisations			
Mean	10.3	10.4	8.6
Std. Deviation	5.8	6.9	5.6
K-S Z	.749	.523	.788

*$p<.05$

Table 6.3 The mean number of intervals each groups of children engaged in each of the 4 measured behaviours. The standard deviations and Kolmogorov-Smirnov Z are also reported. The assumption of normality was met for all data sets except for an inappropriate use of materials by 8-year-olds.

Oneway ANOVAs were conducted to determine if their were group differences in children's activity levels and attention in the classroom. A significant effect was found for attention $F(2,71)=.381$, $p<.05$. Table 6.3 shows that as children get older, episodes of inattention in the classroom decrease. There were no significant interactions found for gross motor activity, inappropriate vocalisations, or inappropriate use of materials.

Pearson's correlations were also conducted to determine if there was any relationship between mean number of delay choices and measures of classroom behaviour, and none of these relationships were significant. (See table 6.4 for the results of the correlation analysis)

	Delay Choice	Gross Motor	Inattention	Materials	Vocalisations
Delay Choice	r=1	r=-.100 p=.403	r=-.126 p=.293	r=.043 p=.717	r=-.208 p=.080
Gross Motor	r=-.100 p=.403	r=1	r=.008 p=.946	r=.096 p=.424	r=.176 p=.140
Inattention	r=-.126 p=.293	r=.008 p=.946	r=1	r=.402 p=.000	r=.334 p=.004
Materials	r=.043 p=.717	r=.096 p=.424	r=.402 p=.000	r=1	r=.253 p=.032
Vocalisations	r=-.208 p=.080	r=.176 p=.140	r=.334 p=.004	r=.253 p=.032	r=1

Table 6.4. Pearson's correlations for the behaviours observed in the classroom and the mean number of choices the children made for the delayed reward across all 3 levels of delay.

A repeated measures Analysis of Covariance (ANCOVA) was run, the between subject factors were age (3 levels) and gender (2 levels), and the within subject factor was the length of delay (3 levels) the 4 classroom behaviours were analysed as covariates. These were included as covariates to determine if changes if the significant differences seen in the groups' preference for delayed rewards were happening independently of changes in classroom behaviour. Where the children's choices related to individual differences that were observed in the classroom. Again, the Mauchley's Test was conducted to test the assumption of sphericity and was found significant, ($W=.72$), $p<.001$, and the Huynh-Feldt correction was used.

A main effect remained the levels of delay to reinforcement ($F(2,124)$[2], $105.22) = 13.9$, $p<.001$. There were no interactions found between the children's responses at different delay times and age, or between delay times and gender. There were also no significant interactions between delay and group, gender, or any of the classroom behavioural measures. A significant effect of age group was found $F(2, 62)=5$, $p=.01$, suggesting that the different groups of children made different numbers of delayed choices. There were no main effects of any of the classroom behaviour measures or interactions between group and gender. The ANCOVA revealed that the significant differences observed in the responding of each group, and their responses at different delay times

[2] The standard df are reported, however the analysis were conducted using the Huynh-Feldt corrected df which were (1.56, 113.36)

occurred independent of the individual differences observed in their classroom behaviour.

Discussion

A clear developmental trend was found in children's preference for delayed rewards, and all of the groups showed a sensitivity to amount and delay. The 4- and 6- year-olds chose the delayed reward less often than the 8-year-olds at all levels of delay. All of the groups chose the larger delayed reward most often when the delay was 30s, less at 60s, and the fewest times at was 120s. This suggests that children in all of the age groups were sensitive to delay.

These data show that as the children got older, their tolerance for delayed rewards increased at all levels of delay. These data support earlier single-trial work that suggests that children's preference for delayed rewards increases as they get older, and that there is a shift in children's choices between ages 5- and 8 –old (Miller et al., 1978, Toner and Smith, 1977). The current data are a more sensitive measure of this pattern because the children were given the opportunity to choose between a small, immediate or larger, delayed reward a total of 10 times at each level of delay. Repeated trials give a more sensitive measure of the child's preference.

This is the first study using a discrete trial methodology to find a preference for delayed rewards in 4-year-olds. In the current study, the young children chose the delayed rewards 7.2 out of 10 times when the delay to the larger reward was 30s. Previous studies have found 4-year-olds to be impulsive or indifferent (Logue and Chavarro, 1992, Logue et al., 1996. Sonuga-Barke et al. 1989a). It is possible that the children in the current study chose the larger, delayed rewards because of the quality of the rewards. The children chose from 10 possible rewards at the start of each trial and the rewards were dispensed as soon as the delay has passed. It is possible that this type of reward and allocation was more reinforcing than what has been used in previous studies.

Solanto et al. (2001) found that choices of a smaller, delayed reward on a computer task correlated with high levels of activity and inattention in the classroom. They suggested that the two behaviours may be functionally equivalent; the children will behave in the way to minimise perceived delay. The current study asked if this relationship is also true with a population of typical children. Correlations were not found between the children's responses on the CTDP and measures of classroom behaviour. This may be because the sample of children was homogeneous and there was not enough variability in the children's behaviour to distinguish between children. It is also possible that the length of observed behaviour was not long enough; the children were only observed for 30 minutes each, and those 30 minutes may not have given an accurate portrayal of the child's activity level. If they were observed

during a particularly dull or exciting lesson, their behaviour may have been different than usual.

It is also possible that the measures used in the current study were not valid. Abikoff, Gittleman, and Klein (1980) found that activity levels and attention in the classroom decreased with age in a population of typical children. In the current study, the only behaviour found to decrease with age was inattention. Abikoff et al. (1980) and Solanto et al. (2001) both used the same code to measure classroom behaviour. Study 2 used a slightly modified version of this code that may not have been as sensitive a measure.

Study 3 will attempts to replicate Solanto et al. (2001) with the computer task and the observed classroom measures used in Study 2. Children with hyperactivity and matched controls will participate in the experiment. The children will also be observed for 3 consecutive mornings rather than just for 30 minutes, as this should provide a more accurate record of the children's behaviour. It is hypothesised that the children's preferences for delayed rewards will correlate with measures of their classroom behaviour in a sample that exhibits more extreme behaviours.

Chapter 7: Study 3
Self-Control in Hyperactive Children and Correlates with Classroom Behaviour

Introduction

Several studies have found that a preference for delayed rewards during a discrete trial task discriminates between children with symptoms of Attention Deficit/Hyperactivity Disorder (ADHD) and their typically developing peers (Schweitzer and Sulzer-Azaroff, 1995; Sonuga-Barke et al., 1992; Solanto et al., 2001). Hyperactive children are more likely than their peers to choose immediate, small rewards instead of larger, delayed rewards.

Solanto el al. (2001) found that these choices of smaller, sooner rewards positively correlated with episodes of activity and inattention in the classroom for children with ADHD. Their data suggest that the delay task may discriminate between children who are more active and pay less attention in the classroom and children who are quieter and more attentive. Sonuga-Barke (1994) suggested that delay aversion underlies both the choices of smaller, immediate rewards and the overactivity seen in children with ADHD.

Study 2 failed to find this relationship with a population of typically developing children. It is possible that the reason Solanto et al. (2001) found correlations and Study 2 did not is because the population of typical children did not suffer from a delay aversion, and the variability in their responding may motivated by different processes. Higher than

average activity levels and inattention to a degree that interferes with school work is part of the diagnostic criteria for ADHD (DSM-IV). Typically developing children exhibit varying levels of activity and inattention in the classroom but it is possible that these variations are subtle, and are not a meaningful indicator of their self-control. Perhaps a relationship between a preference for delayed rewards and classroom behaviour can only be found with a population of children that exhibit a more extreme set of behaviours, such as hyperactive children.

It is also possible that there is a relationship between the classroom behaviour and choices on a delay task in typical children, but the measures used in Study 2 were not valid. The classroom observations differed from those used by Solanto et al., and may not have been as sensitive. The current study seeks to replicate the findings of Solanto et al. (2001) using the same methodology as Study 2. The study will differ from Solanto et al. in a few important ways. During the delay task the children will receive their rewards immediately, rather than earning points that are exchangeable for rewards at the end of the session; the justification for this decision was reviewed in Chapter 4. The children will be observed for three consecutive mornings, rather than the 16 minutes utilised by Solanto et al. The longer observation period should give a greater over view of the children's behaviour. Finally, classroom observation data will be collected for both the hyperactive child and a matched control. Solanto et al. only collected classroom behaviour for the child with ADHD. Observing the behaviour of both groups of children will allow us to determine if the behavioural measures distinguish hyperactive children from their typical

peers, and to determine if the delay task correlates with the behaviour of both groups.

Method

Participants

Thirty male children enrolled in regular education participated; 15 of the children were categorised as "test" participants; they were rated by their parents and teachers as exhibiting above average hyperactivity and inattention. These test participants were referred by The Child and Adolescent Mental Health Services of the North Wales NHS Trust. The children's physicians had referred them for services because of problems with inattention and hyperactivity. Letters were sent home to all of the parents who had children on the waiting list for services. A total of 64 letters were sent out, and of those 25 parents responded, 23 of which met the criteria for participation. The children's parents and teachers all completed the Conner's Parent or Teacher Rating Scale-Long: Revised. The parents completed the Rating Scale in a face to face interview with the primary experimenter, and the teachers completed the scale in their own time. Children whose parents ranked them at or above 86% on the Conner's ADHD Index and the DSM-IV total indices were included in the study. A score above 86% on the ADHD INDEX indicates that the child is at risk for receiving a diagnosis of ADHD, and a score above 86% on the DSM-IV total suggests that the child meets the criteria for a diagnosis of ADHD (Conners, 1997). (See Table 7.1 of the mean scores the children

received for each category.) The mean age of the test participants was 7 years and 3 months, the children ranged in age from 5 years, 2 months to 9 years, 1 month. None of the children received any stimulant medication or received special education services.

Four out of fifteen children had a diagnosis of Attention Deficit/Hyperactivity Disorder. Although this is a small percentage of the sample, it does not accurately represent the severity of the symptoms shown by the remaining 11 children. It is the custom of the local health authority not to diagnosis children with ADHD because of worries that such a label may bias the teachers against the child. That the children were referred for services and that they received high scores on the Conor's Rating Scales indicates that they did exhibit hyperactivity and inattention at a greater rate than their peers.

Fifteen control children were age and gender matched classmates of the test participants. They were referred by their classroom teacher because they exhibited typical levels of attention and activity. The teachers of the control children completed the Conner's Teachers Rating Scale-Revised: Long Version. The parent scales were not completed because it was not always possible to arrange a face to face meeting with the parent's of the control children. All of the children received scores indicating that they were not at risk for a diagnosis of ADHD (See Table 7.1). The mean age of the control children was 7 years and 5 months, and they ranged in age from 5 years 1 month to 9 years, 4 months.

Four pair of girls were run in the study, but their data were not included because of inadequate power to determine if there are any main

effects or interactions of gender. Three pair of boys were excluded because the test participants were diagnosed with Aspergers Syndrome after participating and therefore did not meet the subject requirements. Another 3 pair of subjects began the study, but did not finish because of family moves or school holidays.

Informed consent for the children in the test condition was obtained in a face to face meeting between the experimenter and the child's parents. Consent was obtained for the children in the control condition by means of a letter and permission slip that was sent home with the child from school. All of the children attended Welsh/English bilingual schools, and all were fluent in English.

	Parent's ADHD Index	Parent's DSM-IV Total	Teacher's ADHD Index	Teacher's DSM-IV Total	Teacher's Oppositional
Test					
Mean	74.8	72.4	70.9	74.2	70.87
St. Dev.	15.96	11.4	12.3	11.19	11.03
Control					
Mean	N/A	42.7	43.0		45.13
St. Dev.		2.5	2.43		2.3

Table 7.1. The mean score and standard deviations reported by the children's parents and teachers on the Conner's ADHD Index, DSM-IV total , and oppositional categories. The means are represented as T-scores. A T-score above 61 places the child in the 86 percentile for that category and indicates a possible significant problem. A T-Score above 66 is indicative of a significant problem and places the child in the top 95% of children for the category. T-scores below 45 indicate that the child is at low risk for ADHD.

Setting and Apparatus

Behavioural observations were conducted in the children's classrooms. Each class consisted of between 15 to 30 children. The children sat at tables with 2 to 3 other children. None of the pairs sat at the same table.

The computerised assessment was conducted in an empty classroom or library in the schools on a Toshiba laptop (Satellite 1700) with an external mouse. As in Study 2, a red curtain was hung behind the computer to shield the experimenter who passed the children the rewards. There were no clocks or time keeping devices in the room.

Procedure

Computerised Test of Delay Preference: The participants all participated in CTDP reviewed in Study 2. The only difference was that the children participated in 2 sessions each, and the delay to the larger reward was 60s during both sessions. The first session was considered a practice session because Barkely (2001) noted that hyperactive children show less impulsivity in a novel setting. Previous research suggests that hyperactive children make fewer choices of larger, more delayed rewards on the second day of testing (Schweitzer and Sulzer-Azaroff, 1995), and therefore it may be more revealing of the children's preference to consider their choices after they have become familiar with the task.

Prior to the start of the first session, each child took a short maths test to determine the level of problems they were able to solve. Problems were selected for the CTDP that the children were able to answer correctly 100% of the time.

Classroom Behaviour Observations: Each pair of children were observed simultaneously in their regular classroom for 3 consecutive mornings from 9:00-12:00. Trained observers recorded instances of gross motor activity, inattention, inappropriate use of materials, and inappropriate vocalisations as 10-s partial intervals. The operational definitions of these behaviours are the same as reported in Study 2.

As in Study 2, data were only collected when the children had assigned seatwork or the teacher was giving instructions to the class. Data were recorded when both children were in the room, visible to the observers, and neither child was receiving 1:1 instructions from an adult. Given these limitations and classroom breaks, and average of 111 minutes was observed of each pair of children each day.

Interobserver Agreement. All of the data were coded by the primary researcher, and interobserver agreement was collected for 33% of the sessions for each pair of children. The agreement was collected by the primary researcher with a trained undergraduate psychology student. The average total, occurrence, and non-occurrence agreement were calculated for each interval by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100%. The

occurrence agreement for all of the behaviours across all of the sessions was 93.4%, the non-occurrence agreement was 96.2% and the total agreement was 96%.

Results

Computerised Test of Delay Preference

Table 7.2 shows the mean number of delay choices each group made on both delay task, the standard deviations, and the Kolmogorov-Smirnov test for violations of normality. The assumption of normality was met for both groups at both levels of delay. The test participants made fewer self-control choices than the control participants during both sessions. The test participants made fewer delayed choices on Day 1 than Day 2, and the opposite was true for the control participants.

	Test Participants	Control Participants
Practice Session		
Mean	6.4	7.4
Std. Deviation	2.2	2.5
K-S Z	.751	1.05
Experimental Session		
Mean	5.6	7.8
Std. Deviation	3.1	2.6
K-S Z	.501	.805

Table 7.2 The mean number of times each group chose the larger delayed reward, and standard deviations and Kolmogorov-Smirnov. The assumption of normality was met for the entire sample.

Independent t-tests were conducted to determine if the choices of test and control participants differed during the sessions. During the practice sessions, no significant differences were found between the two groups $t(28) = -1.156$, $p<.05$. However, the hyperactive children made significantly fewer choices of the larger, delayed reward during the experimental session $t(28) = -2.084$, $p<.05$.

A 2X2 ANOVA, with a within subject factor of session (2 levels) and a between subject factor of subject type (2 levels) was conducted to determine if the children's choices were consistent between the practice and experimental sessions. A main effect was found for subject type $F(1, 28)=4.02$, $p=.05$, the test participants made fewer choices of the larger, delayed reward than the control participants. There was no main effect of day or interactions between day and subject type. These data reveal that the group's responses did not significantly differ between the practice and experimental session, therefore the average of the two sessions will be used in the further analysis.

Classroom Behaviour

Table 7.3 shows the means, standard deviations, and Kolmogorov-Smirnov test of normality for the percentage of intervals each group of children engaged in gross motor activity, inattention, inappropriate vocalisations, and inappropriate use of materials. The data were examined for outliers, and 1 value from the category of inappropriate vocalisations and 2 values from the category of inappropriate use of materials were

omitted because they were more than 3 standard deviations above the mean and were considered outliers. The data presented in Table 7.3, and all further analysis are conducted with the amended data sample. Data were collected on three consecutive mornings and averaged together to obtain the results reported below. The children with ADHD showed higher rates of every measured behaviour than their matched controls.

Independent t-tests revealed that the test participants exhibited significantly more episodes of gross motor behaviour t (28)=7.09, p<=.01 and inappropriate vocalizations *t* (27)=6.58, p<. 001, and inappropriate use of materials *t* (26)=6.01, p<. 05. The t-tests did not discriminate between test and control children for inattention.

	Test Participants	Control Participants
Gross Motor Activity		
Mean	13.58	4.33
Std. Deviation	5.3	1.65
K-S Z	.342	.664
Inattention		
Mean	21.27	10.22
Std. Deviation	8.24	5.09
K-S Z	.614	.581
Inappropriate Use of Materials		
Mean	9.44	1.38
Std. Deviation	4.56	1.68
K-S Z	.436	1.24
Inappropriate Vocalisations		
Mean	21.27	6.58
Std. Deviation	8.24	2.71
K-S Z	.436	.641

Table 7.3. The mean number of intervals each group of children participated in each behaviour. The assumption of normality was met for the entire data set.

Relationship between CTDP and Classroom Behaviour. Pearson's Correlations revealed that the children's choices of larger, delayed rewards significantly correlated with gross motor behaviour in the classroom when the data from both groups of children were combined. Their choices on the computer task did not correlate with episodes of inappropriate vocalisations, inattention, or inappropriate use of materials. See Table 7.4 for the correlations for the entire sample of children.

When the data were looked at individually for each group, no significant correlations were found between their choices on the computer task and the observed behaviours.

	Mean number of Delayed Choices
Gross Motor Behaviour	r=-.357 p=.053
Inappropriate Use of Materials	r=-.296 p=.382
Inappropriate Vocalisations	r=-.294 p=.121
Inattention	r=-.247 p=.188

Table 7.4. The correlation between the children's choices of larger, delayed rewards on the computer task and the average number of intervals they engaged in the observed behaviours. The data are the average responses and behaviours of both groups.

Relationship Between the Conner's Index and Direct Measures of Behaviour. The teacher's rating of the children on the Conners' Teachers Rating Scale were correlated with the mean number of delayed choices the children made and mean number of intervals they engaged in the observed behaviours. Table 7.5 shows that the teacher's ratings of the Conner's ADHD index showed significant correlations with the number of choices of the larger delayed reward during the experimental session and all 4 observed behaviours when the data were considered for the entire sample. The teacher's ratings of oppositional behaviour were not correlated with

the children's choices on the CDPT. The teacher's ratings on the DSM-IV total scale showed significant correlations with all the measures of observed classroom behaviour, but not with the children's choices on the delay task. When the data were looked at individually for each group, the teacher's ratings did not show significant correlations with either the children's choices on the computer task or their activity levels in the classroom.

	Teacher's ADHD Index	Teacher's DSM-IV Total	Teacher's Oppositional
Mean number of Delayed Choices	r=-404 p=.027	r=-.296 p<.05	r=-.196 p>.05
Gross Motor Behaviour	r=-.-.712 p<.001	r=.606 p<.001	r=.627 p<.001
Inappropriate Use of Materials	r=-.361 p=.05	r=.395 p=.031	r=.601 p=.001
Inappropriate Vocalisations	r=.613 p<.001	r=.788 p<.001	r=.831 p<.001
Inattention	r=-.758 p<.001	r=.782 p<.001	r=.828 p<.001

Table 7.5. Pearson's correlations between the teacher's ratings of the children on the Conner's Teachers Rating Scale-Long: Revised, the mean number of delay choices, and the measures of classroom behaviour.

Conclusion

The current study sought to determine if the Computerised Test of Delay Preference discriminated between hyperactive and typical children, and if these choices correlated with levels of activity and inattention in the

classroom. Children who had been rated by their parents as having clinically significant problems with hyperactivity and inattention showed a greater preference for smaller, immediate rewards than their typically developing peers. Given a choice to receive 3 treats after a delay of 60s or 1 treat immediately, the hyperactive children chose the larger, delayed reward an average of 6 out of 10 times, their peers chose the delayed reward an average of 7.6 out of 10 times.

It cannot be concluded from these data that the hyperactive children are impulsive. They did not exhibit a preference for smaller, sooner rewards on either Day 1 or Day 2, instead they chose indifferently between the 2 alternatives. These data do not replicate the findings of Sonuga-Barke et al. (1992) who found that hyperactive children choose impulsively on a delay task when there was no post-reinforcer delay. In the current study, the hyperactive children show a significantly greater preference for smaller, sooner rewards than their peers, but they did not choose impulsively. This may because of the type and dispersal of the reinforcers. The children selected from 10 possible treats and received them as soon as the trial was over; previous studies (Solanto et al., 2001; and Sonuga-Barke et al., 1992) rewarded children with points or tokens that were exchangeable for treats after the session was over. The children in those studies may have chosen impulsively because they satiated on the rewards quickly, or because of the additional delay imposed between receiving the token and receiving the actual reward.

The children were observed in the classroom for 3 consecutive mornings. Data were collected on the number of 10s intervals each child

engaged in gross motor activity, inattention, inappropriate use of materials, and inappropriate vocalisations. The hyperactive children showed significantly more episodes of gross motor activity and inappropriate vocalisations, and inappropriate use of materials than their peers; the measure of inattention did not discriminate between the children. There are 3 possible explanations for why inattention failed to discriminate between the two populations of children. The first is that the sample size was too small, only 15 children participated from each group and this may not have provided enough statistical power to reveal a significant difference. The second explanation is that the age range of the children was too variable. Children between the ages of 5- and 9-years-old participated in the experiment. In Study 2 we saw that episodes of inattention declined as children got older; it is possible that age was confounded with participant type in the current study. There were not enough participants in different age groups to test if this hypothesis is correct. The final explanation in an acceptance of the null hypothesis: the test and control participants do not differ in the amount of time they spent failing to pay attention to their teacher of lessons. If the final explanation is true it would suggest that the measure is not sensitive enough to discriminate the hyperactive children from controls. The parents and teachers of the children confirmed that the test children exhibited extreme levels of inattention and the controls exhibited average levels of inattention. More subjects should be run in this study to determine if the measure of inattention failed to discriminate between the test and control children because of too little statistical power, or because the measure was

not sensitive enough to capture the differences in attention levels reported by the parents and teachers.

The children's choices of smaller, immediate rewards positively correlated with the average number of intervals they engaged in gross motor activity. Significant correlations were not found for their preference for delayed rewards and episodes of inattention, inappropriate use of materials, and inappropriate vocalisations. It is unsurprising that no relationship was found with the variables of inattention or inappropriate use of materials because these two measures did not discriminate between the test and the control children, and it is possible that they may not be valid measures of the test children's overactivity or inattention.

The correlation found between the children's choice of larger, delayed rewards and their gross motor activity somewhat replicates the findings of Solanto et al. (2001), who found correlations using only a population of children who had a diagnosis of ADHD. The current study failed to find a relationship using only the hyperactive subjects, and only found a relationship when the entire sample of test and control participants were included. One possible explanation for this is the size of the sample, Solanto et al. (2001) tested 77 participants and the current study only examined 15 hyperactive children. It is possible that the current study would find a significant relationship between delay choices and classroom behaviour as the sample size increased. A second possibility is that the children in Solanto et. al's study were rigorously diagnosed with ADHD; the children in the current study were on a

waiting list to receive an assessment. Although the parents and teachers rated the test children as likely candidates for a diagnosis of ADHD, their opinions form only one part of a proper diagnosis (Barkely, 1988). It is possible that some of the participants would not receive a diagnosis during a more rigorous assessment, and therefore their choices of smaller, immediate rewards and activity levels in the classroom might not differ significantly from their peers. The final reason the current study may not have found significant correlations is because the measures of classroom behaviour were not sensitive enough to reveal the relationship. Again, running more subjects in the current study will help distinguish amoung these possibilities.

In conclusion, the computer task did discriminate between the children with hyperactivity and their typical peers. These choices correlated with the number of times the children exhibited gross motor activity in the classroom, and their teacher's reports of their activity and attention. Barkley (1990) suggested that tasks that discriminate between children with ADHD and their peers should be related to other, observable behaviours. The delay task meets these criteria for ecological validity because the children's choices are related to direct measures of how often the move about the classroom, and the indirect measures of teacher's reports.

The current study found a relationship between the children's choices and their activity levels in the classroom when hyperactive children were included in the sample; Study 2 did not find such a relationship when only typically developing children were used. These

data suggest that the link between choices of smaller, delayed rewards and overactivity in the classroom may be stronger in children who exhibit clinically significant levels of hyperactivy and inattention than in typical children. This link will be explored in more detail in the following chapter.

Chapter 8: General Discussion

As reported in Chapter 1, self-control can be defined as a preference for larger, delayed rewards over smaller, sooner rewards. It has been well documented that animals in the laboratory choose impulsively, i.e. they prefer the smaller, immediate reward. (Ainslie, 1974; Mazur and Logue, 1978; Rachlin and Green, 1972). When positive reinforcement is used in the laboratory, adult humans show a preference for the larger, delayed rewards (Logue et al., 1986; Logue et al., 1990). The research with children has been equivocal. Some research suggests that children as young as 4-years-old are sensitive to delay and amount, and they prefer delayed rewards in the right conditions (Mischel and Ebbson, 1970; Mischel et al., 1972, Yates et al., 1981). Using a discrete trial paradigm, other studies have concluded that young children are either not sensitive to delay and amount or prefer smaller, immediate rewards (Logue and Chavarro, 1992, Logue et al., 1996; Sonuga-Barke et al., 1989a, 1989b.)

The current research sought to explore the questions about children's preference for delayed rewards. In particular, the research asked: a.) Do children discount the value of delayed rewards?, b) Does children's preference for delayed rewards increase as they get older?, c) Are there gender differences in children's preferences for delayed rewards?, d) Are children who are categorised as hyperactive by their parents and teachers more inclined to prefer smaller, immediate rewards than their peers? and e.) Does a preference for delayed rewards

correspond to other behaviours, such as children's behaviour in the classroom?

Summary of Research Studies

Study 1. Children ages 3-to 5-years old participated in a single subject research study to evaluate their preference for delayed rewards. They chose to receive one sticker after a 5s delay or three stickers after longer delays. The delay times were adjusted for each child to determine when they preferred larger delayed rewards and the point at which they preferred smaller, immediate rewards.

All of the children switched from a preference for larger, delayed rewards or indifference to a preference for small, immediate rewards as the length of the delay increased. The 5-year-olds chose the larger rewards at much longer levels of delay than the 3- and 4-year-olds. These data raised the possibility that children's tolerance for delayed rewards may increase as they get older. A second interpretation of the data is that children show variability in their responding during a delay task, as was suggested by the slight differences in the responding of the 3- and 4-year-olds. Study 2 was designed to address both of these questions.

Study 2. Children ages 4-, 6, and 8-years-old participated in a group design experiment. All of the children chose to receive one treat after a 2s delay, or three treats after delays of 30, 60, or 90s. Each child experienced all 3 levels of delay over the course of 3 experimental sessions on a Computerised Test of Delay Preference (CTDP). The data were

analysed to determine if children's preference for delayed rewards increased as they got older, and if children at all ages discounted the value of the delayed rewards, i.e. did they choose the larger rewards more often when the delay was 30s than when it was 120s. The children were also observed in the classroom for 30 minutes each and data were collected on their attention and activity levels in the classroom. These data were correlated with the number of times the children chose the larger, delayed reward to determine if children who preferred to wait for larger, delayed rewards also showed less activity and paid better attention in the classroom than children who preferred smaller, immediate rewards.

The data revealed that the 8-year-olds showed a greater preference for larger, delayed rewards at all levels of delay than the 4- and 6- year-olds. All three groups of children preferred the larger rewards most often when the delays were 30s, less when the delays were 60s, and least when the delays were120s. No gender differences were found for either the type of choices the children made on the CTDP or for instances of classroom behaviour.

The children's choices did not correlate with measures of their classroom behaviour. It is possible that there is no relationship between children's choices on a CTDP and their classroom behaviour, or it may be the measures of classroom behaviour were not valid or sensitive enough to reveal this relationship. Study 3 asked if the measures used in Study 2 would discriminate between a population of hyperactive and typically developing children, and if their choices on the CTDP correlated with classroom behaviour.

Study 3. The participants for the final study were boys who had been identified by their classroom teacher and parents as exhibiting hyperactive behaviours and inattention in the classroom. Each of these test participants were matched with a classmate who served as a control participant.

These children participated in the CTDP for 2 sessions; during both sessions they chose to receive 1 treat after 2s or 3 treats after a delay of 60s. The children were observed in the classroom for 3 consecutive mornings on the same measures of behaviour utilised in Study 2. The data revealed that the test participants made significantly more choices of the smaller, delayed reward on the second day of testing than the control participants, and the choices for each group correlated with measures of gross motor activity in the classroom. The behavioural measures of gross motor activity and inappropriate vocalisations distinguished between the hyperactive and control children, suggesting that they are valid measures for determining individual differences in behaviour.

The data will be discussed in terms of the 4 previously stated research questions.

Research Question 1: Are young children sensitive to delay and amount, and do they discount the value of delayed rewards?

Prior to the current research, there has been little research asking if young children discount the value of delayed rewards. Studies with

adults have found that the subjective value assigned to a given reward diminishes the further in the future that the reward is available (Rachlin et al., 1992). Green et al. (1994) found that 12-year-old children discount the value of delayed rewards more rapidly than adults, suggesting that a preference for larger, delayed rewards increases with age. Similar studies have not been conducted with younger children.

Logue et al. (1996) found that 3-, 5, and 7- year-old chose a larger reward equally when the delays to receiving it were 15 or 30s. This is a very small difference in the amount of delay, and young children may not view the 15s difference as meaningful. Sonuga-Barke et al. (1989a, 1989b) found that young children become more sensitive to amount and delay as they get older, but did not specifically test the hypothesis of whether their preference for larger, delayed rewards decreases as the delays become longer.

The data from Study 1 and Study 2 both suggest that children do discount the value of delayed rewards. In Study 1, all of the children chose the larger reward more often when the delays were shorter and less as the delay to the larger reward increased. Both of the 5-year-olds and two out of five of the 3- and 4-year-olds chose the larger reward more often than the smaller reward when the delays to the both rewards were equal, became indifferent between the two alternatives as the delays increased, and switched their preference to smaller, immediate rewards when the delays became longer. These children showed that they were sensitive to both delay and amount; they preferred the larger reward when the delays to both rewards were equal, indicating that they preferred larger to

smaller rewards, and they showed sensitivity to delay by discounting the value of those larger rewards when the delay period became longer.

Of the remaining participants in Study 1, two 4-year-olds and one 3-year-old were indifferent between the larger and smaller rewards when the delays to both rewards were equal, suggesting either that they might not be sensitive to the amount of reward, i.e. they have not decided that more is better. It is possible that children were sensitive to amount but that the rewards used in the study were not reinforcing. These children did show sensitivity to delay when the they switched from a pattern of indifference to a preference for smaller, sooner rewards as the length of the delay increased; suggesting that they were adverse to long delay times. These data replicate previous work (Logue and Chavarro, 1992; Logue et al., 1996, and Sonuga-Barke et al., 1989a) that found that 3- and 4-year-old children are indifferent to between smaller and larger rewards when the delay to the larger rewards was between 15- and 50s.

In Study 2, all 3 groups of children chose the larger reward most often when the delays to receiving them were 30s, less often at 60s, and least often at 120s. These data suggest that 4-, 6, and 8-year-old children are all sensitive to amount and delay and discount the value of delayed rewards.

These are the first data to show that young children are sensitive to delay, and that they do discount the value of delayed rewards. In Study 1, the 3- and 4-year-old children were impulsive or indifferent between the larger and smaller rewards when the delays were between 30 and 90s, replicating previous findings. It was not until the delays were over 120s

that the children consistently chose the smaller, immediate reward. However, in Study 2, children ages 4 years 1 month to 5 years 2 months chose the larger reward an average of 7 out of 10 times when the delay to the reward was 30s, suggesting that they preferred the larger, delayed reward. When the delays were 60s and 120s, they chose the larger, delayed reward only 6.2 and 5.5 times out of 10, respectively, suggesting that they were indifferent between the two alternatives. This is the first study to find 4- to 5-year-old children consistently choosing the larger, delayed reward at any level of delay.

This study differed from previous studies in the type of reinforcers used. In Study 2, the children chose from an array of 10 possible rewards before the start of each trial. In previous studies, including Study 1 the children received the same type of reward during all the trials, and they may have satiated on reward early in the session. In Study 2 the rewards were more varied and the children may have chosen the larger, delayed rewards more often because they found the rewards more reinforcing.

A second possibility for the difference in findings in the 4-year-olds in Study 1 and Study 2 may be the level of the children's schooling. The 4-year-olds in Study 1 were enrolled in a day nursery, whereas the same age children in Study 2 were enrolled in a reception class at an infants school. It is possible that the structure in a reception class may have given the children more experience waiting for delayed rewards, and therefore they were more willing to wait for the rewards during the CTDP.

Further research would be needed to determine which of these explanations explain the differences in responding seen by the children in Study 1 and Study 2.

The data from Study 1 and Study 2 support the hypothesis that children discount the value of delayed rewards. All of the children in Study 1, and all 3 groups in Study 2 chose the larger reward less often at longer delays than at shorter delays. The data from both studies suggest that the children are sensitive to delay.

It is not perfectly clear from these studies if young children are sensitive to the amount of the reward. Some of the children in Study 1 never indicated that they preferred to receive more stickers. It may be that the children did not prefer more reward, or perhaps their indifference was related to the quality of the reinforcement. This study should be replicated using a variety of reinforcers with the same population. If the children never show a preference for delayed rewards it may indicate that they are not sensitive to reinforcer amount.

The children in Study 2 did prefer the larger reward when the delay to receiving it was 30s, suggesting that they did prefer more rewards. Again, this difference may be explained either by differences in reward quality or level of education the children had received.

Research Question 2: Does children's preference for delayed rewards increase as they get older?

As reviewed in Chapter 2, previous studies using a discrete trial methodology have failed to find developmental changes in children's preference for delayed rewards (Logue et al., 1986). Studies using a single trial methodology have found an increase in children's preference for delayed rewards between 5- and 8- years (Miller et al., 1978; toner and Smith, 1977; and Yates et al., 1981), and another increase between ages of 9- and 10-years-old (Mischel and Metzner, 1962). The current discrete trial studies support the findings of the single trial work.

In Study 1, the 5-year-old children chose the larger delayed rewards at longer levels of delay than the 3- and 4-year-olds. As this was a single subject methodology, the children all experienced slightly different conditions and there were too few subjects to properly compare their data. Study 2 was designed to test for age effects. It was found that the 4- and 6-year-olds chose the delayed rewards an equal number of times, and fewer than the 8-year-olds at all levels of delay. These data suggest that there are not developmental changes between ages 4- and 6-years-old, but there is a change between ages 6 and 8.

These are the first data using a discrete trial paradigm to find age differences in children's preference for delayed rewards. As discussed in Chapter 4, these data are valuable because the children were aware of the contingencies when they made their choices and chose between the larger and smaller rewards over a series of trials. The proportion of LDR out of of 10 responses give a more sensitive measure of children's preference for delayed rewards than does 1 choice.

These data support the hypothesis that children do develop a greater preference for delayed rewards as they get older. It is possible that the developmental data can bridge the difference between the impulsive responding seen in non-human animals (Ainslie, 1974; Rachlin and Green, 1972) and the self-controlled responding observed in adults (Logue et al., 1996) .

As children get older they develop more sophisticated language and reasoning abilities, and these may help them bridge the delay between selecting a larger reward and receiving it. Mischel and Mischel (1982) suggested that older children are better at identifying strategies that help them wait for delayed rewards. It is also possible that older children have had more experience with delayed rewards and preference for and ability to wait for delayed rewards is a skill that children acquire with practice. Future research should be done to determine why children's preference for delayed rewards increases as they get older.

Research Question 3: Are there gender differences in children's preference for delayed rewards?

Previous research has suggested that girls may be better at waiting for delayed rewards than boys. Logue and Chavarro (1992) found that 4-year-old girls were indifferent between receiving larger, delayed rewards and smaller, sooner rewards and 4-year-old boys preferred the smaller, immediate rewards. Funder et al. (1983) found that 4-year-old girls exhibited greater self-control than boys on their delay of gratification

tasks, and that self-control in girls was correlated with intelligence, competence, and resourcefulness. The boys who delayed gratification the longest tended to be rated by their teachers as attentive, reflective, and having good concentration. Funder et al. (1983) suggested that the differences both in the ability to delay gratification and the correlates of such an ability stem from the different ways boys and girls are socialised. They hypothesised that girls are taught to inhibit their emotional and behavioural impulses more than boys therefore are better able to delay gratification.

Study 2 did not find any gender differences in children's preferences for delayed rewards for any of the three age groups. These data support several other studies, which also failed to find gender differences (Darcheville et. al., 1992; Logue et al., 1996; Mischel and Ebbson, 1970, Mischel et al., 1972; Yates et al., 1981).

It is possible that Logue and Chavarro (1992) found gender differences because they had a relatively small sample size, 9 boys and 11 girls participated in their study. If they had a larger sample they may not have found gender differences. They did not find gender differences using the same paradigm in a later study (Logue et al., 1986) As discussed previously, the girls in their study showed a preference for alternating drawers which may have been a artefact of the no choice trials and affected their preferences.

The tasks used by Funder et al. (1983) did not ask children to choose between a smaller, immediate reward and a larger, delayed reward, but instead asked children not to engage in an attractive activity.

It is possible that the skills children needed to succeed in Funder et al.'s (1983) task are different than those needed to wait for larger, delayed rewards. The skills needed in Funder et. al's task may develop earlier in girls than in boys; however the data in the current study do not suggest that girls develop a preference for larger, delayed rewards sooner than boys.

The age range used in Study 2 was small, only children between the ages of 4- and 8-years-old were tested. It is possible that there may be gender differences in younger children or in adolescents.

Research Question 4: Are children who are categorised as hyperactive by their parents and teachers more inclined to prefer smaller, immediate rewards than their peers?

Study 3 sought to replicate previous research which had found that children identified as hyperactive and inattentive make few choices of larger, delayed rewards on test of delay preference than their peers (Schweitzer and Sulzer-Azaroff, 1995; Sonuga-Barke et al., 1992; Solanto et al., 2001).

In the current study boys ages 5-9 years-old participated. Half of the boys had been identified by their parents and teaches as having problems with hyperactivity and inattention. The remaining half were age and gender matched classmates. The children chose to receive 1 treat after 2s or 3 treats after a delay of 60s. The children participated in the

experiment for two days; the contingencies were identical during both sessions.

The data revealed that the both groups of children chose the delayed reward an equal number of times on Day 1. On Day 2, the hyperactive children chose the smaller, immediate rewards fewer times than on Day 1, and the control group showed the opposite pattern of responding. On Day 2, the control group chose the larger, delayed reward significantly more often than the hyperactive children. Schweitzer and Sulzer-Azaroff (1995) found that hyperactive children made fewer choices of larger, delayed rewards as the sessions progressed. They suggest that hyperactive children satiate on rewards more quickly than typical children, and are therefore less inclined to wait for larger, delayed rewards as the sessions continue. In the current study, the children chose from an array of 10 possible rewards; it is possible that they satiated on these after the first session. A second explanation for the change in responding may be that children with ADHD display fewer instances of hyperactivity and impulsivity in novel situations (Barkley, 1998; Zentall, 1985). Further research should be done to determine which of these possible hypothesis explain the data.

Different theories have been proposed to explain why hyperactive children make more impulsive choices on a CTDP than their peers. Schweitzer (1996) argued that the hyperactive children are impulsive, that they prefer immediate reward even when though they may receive less overall reinforcement. Sonuga-Barke (1996) suggested that the children are not impulsive, but delay averse. They will behave in a way to reduce

overall levels of delay. The current study does not offer any new insight into this debate, more work should be conducted in the future to determine which of these hypotheses are accurate.

The data from Study 3 and previous work suggests that the Computerised Test of Delay Preference discriminates between children who have been identified as hyperactive by their parents and teachers from a group of control children.

Research Question 5: Does a preference for delayed rewards correspond to other behaviours, such as children's behaviour in the classroom?

The data reviewed has suggested that the CTDP can discriminate between children of different ages, and between hyperactive children and their peers. The final research question addresses the ecological validity of these findings. Barkely (1991) argues that any task that discriminates between clinical and typical populations should to some extent correlate with behaviours that occur in the natural environment. The higher the correlation, the better the ecological validity.

Solanto et al. (2001) found that the choices made by children with ADHD on a CTDP correlated with instances of classroom behaviour. Children who made more choices of the smaller, immediate reward were more likely to be active and inattentive in the classroom. Their data suggest that the skills children need to wait for a delayed reward may be the same skills needed to remain calm and attentive in the classroom. Sonuga-Barke (1994) suggested that choices of a smaller, immediate

reward and hyperactivity and inattention in the classroom are both manifestations of delay aversion. In both scenarios, the children are behaving in such a way to reduce their overall levels of delay.

In Study 2, this hypothesis was tested with a group of typical children. As children get older, their instances of activity in the classroom decrease (Abikoff, Gittelman, and Klein, 1980). Study 2 asked if these decreases in activity level were related to an increase in the number of delayed choices on the CTDP. A second alternative is that there is a relationship between the children's choices on the CTDP and classroom behaviour, but these changes are not related to age but represent individual differences.

In Study 2, it was found that children did make more choices of the larger, delayed reward between ages 6- and 8-years-old. The classroom data revealed that the children showed decreasing episodes of inattention as they got older, but there were no age effects for gross motor activity, inappropriate use of materials, or inappropriate vocalisations. There was no relationship between the number of larger, delayed choices the children made and episodes of inattention, gross motor behaviour, inappropriate use of materials, or inappropriate vocalisatoins in the classroom.

From these data it appears that the skills typical children need to wait for a delayed reward are not related to the skills they need to attend and behave in the classroom. However, it is possible that the sample was too homogeneous; perhaps there was not enough variability in the children's behaviour or choices to determine if there are correlations. A

second possibility is that the measures of classroom behaviour were not sensitive. Solanto et al. (2001) and Abikoff et al. (1980) used a different classroom behaviour code that may have been more sensitive to individual differences in behaviour. To test these hypotheses, children who had been identified as exhibiting extreme hyperactivity and inattention in the classroom, and a control group of children who were rated by their classroom teachers as typical participated in a similar experiment.

The hyperactive children exhibited more episodes gross motor activity, inattention, inappropriate vocalisations, and inappropriate use of materials than the controls. It was found that the children who made more choices of smaller, immediate rewards on the CTDP also exhibited higher rates of gross motor behaviours; there was not relationship between choices on the CTDP and the other three behaviours. The correlation between gross motor behaviour and choices on the CTDP suggests that the skills that children need to wait for larger, delayed rewards may be related to the skills they need to inhibit walking around and fidgeting in the classroom.

These data replicate those of Solanto et al. (2001) who found that the children's choices of smaller, immediate rewards correlated with episodes of gross motor activity in the classroom. They also found a correlation with aggression, which was not tested in current studies.

The relationship between responding on the CTDP and classroom behaviours was only found when a sample of children who exhibit extreme behaviours were used, and not with population of typical

children. It is possible that the delay task was not a sensitive enough to discriminate the variations in classroom behaviour of typical children, or that the measures of classroom behaviour were sensitive enough to pick up individual differences.

It is also possible that the differences in the choices or behaviour of the typical children were not clinically significant. The children in Study 3 exhibited levels of impulsivity and hyperactivity to a degree that negatively affected their academic success and social relationships. Although their may have been variability in the responding of the children in Study 2, this variability may not be related to their academic and social functioning.

In sum, it appears that the CTDP is related to behaviours observed in the natural environment for children who exhibit extreme levels of activity in the classroom.

Future research should be conducted to determine if children who show a greater preference for smaller, delayed rewards when they are young are at risk to develop behaviour problems when they get older. If the underlying mechanism for hyperactivity and a preference for smaller, sooner rewards is the same, it would be expected that any treatment that found an improvement in hyperactivity would also affect a change in the preference for delayed rewards.

Research Question 6: Is A Preference for Delayed Rewards a Developmental or Individual Process?

It is unlikely that a preference for delayed rewards is either strictly a developmental process or a trait that varies by individual. The current research provides evidence for both alternatives. The 8-year-old children in Study 2 showed a greater preference for delayed rewards than the younger children, suggesting that age does play a role in how children assign value to delayed rewards. The hyperactive children in Study 3 chose the smaller rewards more often than their same age peers, suggesting that individual differences play a role in children's preferences for delayed rewards.

Future studies should investigate the interaction between development and personality. Mischel and colleagues (Mischel et al., 1998, Shoda et al., 1999) found that children who were able to wait longer when they were 4-years-old showed greater academic and social competence in adolescence than the children who waited less time when they were young. It would be interesting to conduct longitudinal studies to determine if a preference for larger, delayed rewards develops at a similar pace for all children. Do all children show an increased preference for delayed rewards as they get older, only some children will show a greater preference in early childhood and therefore will always appear more self-controlled than their peers? Do typical children and children with ADHD both show an increase in delayed rewards across development, and if so, is there a measurable developmental lag between for the children with ADHD? Is there a point in development when children show a large increase in their ability to wait for delayed rewards, as if so, what other cognitive abilities emerge at the same time? Are children who participate

in sports or other activities more likely to develop a greater preference for delayed rewards? Is it a skill that can be taught? Future research should help answer some of these questions.

The Definition of Self-Control

Self-control has long been defined as a preference for larger, delayed rewards (Ainslie, 1974; Logue, 1995; Rachlin and Green; 1972). Participants who chose to receive smaller, immediate rewards were labelled "impulsive" and those who chose the larger, delayed rewards were considered to show "self-control." This definition assumes that the larger reward is always of a higher value than the smaller reward. Sonuga-Barke et al. (1992a, 1992b) point out that this assumption is not always true. Children with ADHD may rate escaping an experimental situation as a higher value reward than obtaining more points on a computer game. If they choose the smaller, immediate reward but get to leave early, they are choosing in a way that maximises their total reinforcement. The current data are discussed in terms of delay aversion.

Delay Aversion

As reviewed in Chapter 3, Sonuga-Barke et al. (1992a, 1992b) found that children with ADHD show a greater preference for smaller, immediate rewards than their peers when the choice results in less overall time in the experimental session, and seek to minimise delay on memory

tasks (Sonuga-Barke et al., 1992b). He further suggests that this delay aversion is "functionally equivalent" to the over-activity and inattention observed in children with ADHD (Sonuga-Barke, 1994).

He extends this theory to an interpretation of Mischel's delay of gratification procedure (Sonuga-Barke, 1988). It is possible that the children in the study chose the smaller reward because they placed a higher value on leaving the experimental session early than they did on the social and tangible rewards associated with waiting for the larger, delayed rewards. Hence, it is inappropriate to term the children in the unfavourable waiting conditions "impulsive".

None of the 3 studies reported in the current thesis utilised a post-reinforcer delay, and therefore conclusions cannot be drawn as to whether the children made self-controlled or impulsive decisions. The children may have chosen the smaller, delayed option because they were in a hurry to return to their class or because they were uncomfortable in the experimental session. Attempts were made to control for this by only running the study during class time and never during recess, assemblies, or unusual activities that occurred in the classroom. However, it is impossible to know what the children found reinforcing without doing a functional analysis.

It might be possible to test if children choose impulsively by setting up an experiment where the children left a less preferred situation to participate in a delay task they rated as more preferred. The children would be told they had to stay with the experimenter for 30 minutes regardless of how they spent their time. They can complete a delay task

with no post-reinforcer delay, and if they finish early they would need to spend some time sitting in a quiet room completing a tedious task. If they choose the larger, delayed reward more often, they would have less time to spend in a quiet room. If the children show a preference for the larger, delayed reward more often we cannot conclude that they prefer the delayed reward, they may simply be trying to avoid a more tedious delay in the quiet room. However, if they choose the smaller, immediate reward even though this means more time in a less reinforcing activity, we might conclude that they have a preference for smaller immediate rewards, and this preference might be judged impulsive.

The current data do provide some support for the hypothesis that a delay aversion may link a preference for shorter experimental sessions and hyperactivity in the classroom. Sonuga-Barke (1994) argued that

> "children who are regarded as hyperactive differ from other children primarily in the way in which they are motivated with regard to time in general and delay in particular...the functions of these children's impulsiveness, inattention, and overactivity are signified by the same minimand: the minimisation of delay." (pg 809).

There are two possible ways to interpret this idea. One is that delay aversion is a behavioural continuum, some children are more delay averse than others, and children with hyperactivity show behaviour at the extreme end of delay aversion. If this was the case, we would expect to see all children's choices on a delay task correlating with their activity levels in the classroom. Children with a greater preference for delayed rewards would show less activity in the classroom, children with an average

preference would show average activity levels, etc. Study 2 did not show these pattern of results, suggesting that the two behaviours are not linked in typical children.

A second way to interpret the statement is that delay aversion is a pathology seen in children with hyperactivity. The behaviour is not seen in a population of typical children. If this is the case, we would expect to see the results shown in Studies 1 and 2. The children's choices of delayed rewards did show a relationship to their classroom behaviour, these relations only emerged in a sample of hyperactive children. These data do suggest that the choices of smaller immediate rewards (or a shorter experimental session) are linked to overactivity in the classroom. It is possible that the two behaviours share the underlying mechanism of delay aversion.

Future Research Questions

It would be interesting in the future to study self-control from the perspective of how children choose between higher and lower value rewards. Most of the research to date has only considered how a person chooses between more or less of a reward. The generalised Matching Law discussed in Chapter 1 identified some of the other factors that contribute the to the subjective value a person places on a reward, these are the amount of reinforcement, the rate of reinforcement, the quality of reinforcement, the delay to reinforcement, and the effort needed to obtain

the reinforcement (Baum, 1979). Perhaps a better definition of impulsivity would be "a choice that minimises a person's overall subjective reinforcement." A person who chooses rewards of less value may be considered impulsive. Logue and King (1991) found that adults choose a smaller amount of a drink over a larger amount of drink when they are thirsty, suggesting that deprivation may make a person impulsive. It is a philosophical distinction if a person can ever minimise their total subjective reward, perhaps we always choose the alternative we value the most. However, it is clear that sometimes people choose in such a way that minimises their long term reinforcement. Alcoholics value a drink now over sobriety now, but may value a year of sobriety more than a year of drunkenness. Children with ADHD rate escaping a tedious task now as more reinforcing than attending to their lessons, but they may rate being held back a year in school as much lower value.

Future research should investigate the choices a person makes that result in immediate high value reinforcement but leads to low value consequences. How does this knowledge develop, and what is the role of development and individual differences. How can a person be taught to distinguish between these consequences?

Summary

The current studies found that children ages 3- to 8-years-old do discount the value of delayed rewards. The children in the studies chose larger, delayed rewards more often than smaller, sooner rewards when

the delays to receiving the larger rewards were relatively short. As the delays increased, they chose smaller, sooner rewards more frequently.

It was found that children's preferences for delayed rewards does increase as they get older. Study 2 found that 8-year-olds chose to receive larger, delayed rewards more often than 4- and 6-year-olds when the delay to the larger rewards were 30s, 60s, and 120s.

The data regarding individual differences in a preference for delayed rewards and the relationship with classroom behaviour was less clear. No relationship was found for a population of typical children between the ages of 4- and 8-years-old. A positive correlation was found between the gross motor activity levels of hyperactive children and their choices of smaller, sooner rewards on a CTDP. These data suggest that hyperactive children's choices on a delay task and their overactivity may be linked to an underlying delay aversion (Sonuga-Barke, 1994) or impulsivity (Barkley, 1997).

A preference for delayed rewards is a skill that most adults need to succeed in the modern world. The current studies suggest that this preference is a skill that develops as children age, and that children who do not develop this skill are at risk in other areas of their life. Future research should be conducted to determine the how children's preference for delayed rewards improves with age, and how this skill can be taught to children who do not develop it naturally.

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