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A Behavioral Overview of Self-Control

Shannon Kay Swick

Western Michigan University

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A BEHAVIORAL OVERVIEW OF SELF-CONTROL

by

Shannon Kay Swick

A Thesis
Submitted to the
Faculty of The Graduate College
in partial fulfillment of the
requirements for the
Degree of Master of Arts
Department of Psychology

Western Michigan University
Kalamazoo, Michigan
April 1992

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A BEHAVIORAL OVERVIEW OF SELF-CONTROL

Shannon Kay Swick, M.A.
Western Michigan University, 1992

The present paper is a review of behavioral self-control literature with self-control defined as the choice of a larger, more delayed reinforcer over a smaller, less delayed reinforcer. The paper includes a self-control experiment in which the subjects were adolescent males labelled Attention-deficit Hyperactivity Disorder. The results show higher levels of self-control than those generally seen in similar subject populations. Self-control literature in behavioral psychology is examined and explanations for varying results are discussed.
ACKNOWLEDGEMENTS

I wish to express special thanks to my advisor and committee chairperson, Dr. Roger Ulrich, for his support, guidance, flexibility, and encouragement throughout my course of study. I also wish to expressly thank Dr. Alan Poling, for his assistance and guidance from the beginning of this project, and Dr. Neil Kent for his support as a committee member.

Appreciation is expressed to Dylan Schmorrow for his help in construction of the apparatus, and his friendship and support throughout. Appreciation is also due to Chris Vreeland for his assistance in proofreading and his unending patience.

Last, but not least, my deepest gratitude and thanks are given to my parents, Ora and Sandra Swick, and my grandmother, Beatrice Duckett, without whose continuous love and encouragement I would have never made it this far.

Shannon Kay Swick
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A behavioral overview of self-control

Swick, Shannon Kay, M.A.

Western Michigan University, 1992
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CHAPTER I

INTRODUCTION

Both self-control and impulsiveness are behaviors that have been of interest to psychologists. Why do people choose the short term pleasure of smoking a cigarette (impulsiveness) though they know that cigarette smoking is the number one preventable cause of death and thus not beneficial in the long run? Why do we snack on potato chips, rather than raw vegetables, when we know the long term benefits of the vegetables?

A substantial body of literature has developed in an attempt to answer these questions. The literature is expansive and has shown varying results. The purpose of the present paper is to examine self-control from a behavioral perspective.

Self-control has been defined as the choice of a larger, more delayed reinforcer over a smaller less delayed reinforcer, while choice of the smaller, less delayed reinforcer constitutes impulsiveness (Ainslie, 1974; Rachlin & Green, 1972).

Studies on self-control, as defined above, can be placed in three categories based on the characteristics of the subjects: (1) nonhuman subjects, (2) children and mentally impaired subjects, and (3) adult human subjects. In the confines of these experiments, it has generally been found that nonhumans, children, and the mentally impaired behave impulsively, while adult humans generally display self-control.

Pigeons, under a variety of conditions, select the immediate, small reinforcer (Ainslie, 1974; Logue, Rodriguez, Pena-Correal, & Mauro, 1984; Mazur & Logue, 1978; Rachlin & Green, 1972), and only through extensive training come to select the delayed, large reinforcer (Fantino, 1969; Mazur & Logue, 1978). For example,
Rachlin and Green (1972) studied self-control in pigeons using a concurrent schedule procedure. When offered a choice between a small, immediate reinforcer and a larger reward delayed by 4 s, the pigeons consistently selected the smaller, immediate reinforcer, thus, by definition, behaving impulsively. Only through extensive training have pigeons been taught to delay reinforcement. For example, Mazur and Logue (1978) used an extensive fading procedure, consisting of 11,000 trials, to teach experimental subjects to wait for the larger, delayed reinforcer.

Children and mentally impaired subjects, like pigeons, generally choose the immediate reinforcer (Burns & Powers, 1975; Mischel, Ebbesen, & Zeiss, 1972; Ragotzy, Blakely, & Poling, 1988; Schweitzer & Sulzer-Azaroff, 1988). Mischel et al. (1972) examined self-control in pre-school children. When experimental conditions were arranged to allow the children to choose between a less preferred, less delayed reward (pretzels) or a more preferred reward (marshmallows) delayed up to fifteen minutes, they found that the children consistently selected the smaller reinforcer in less than a one minute wait. Ragotzy et al. (1988) examined self-control in non-verbal mentally retarded adolescents. These subjects also chose the smaller alternative when there was a significant delay to the larger reinforcer. Subjects chose the smaller reinforcer over the larger, in trials with delays of 10 s, 20 s, and 30 s respectively for the three subjects in their study.

Given the initial definition of self-control and impulsiveness, adult humans are the only subject group that have consistently displayed self-control (Buskist & Miller, 1981; King & Logue, 1990; Logue, Pena-Correal, Rodriguez, & Kabela, 1986; Navarick, 1986). Adult humans have displayed impulsiveness under only one condition: when termination of white noise was used as a negative reinforcer (Navarick, 1982; Solnick, Kannenberg, Eckerman, & Waller, 1980).
The results of self-control studies are thus quite consistent within subject groups, in that nonhumans, children and mentally impaired subjects behave impulsively, while adult humans exhibit self-control. The present paper will present data on a self-control study with adolescent boys labelled Attention-deficit Hyperactivity Disorder, review the self-control literature, and discuss some issues involved in self-control not addressed by the experimental procedure common to the behavioral literature.
CHAPTER II

SELF-CONTROL EXPERIMENT

It is estimated that 3% to 5% of the child population is hyperactive (Barkley, 1983). Hyperactivity is one of the most frequent reasons for referral to child guidance clinics and one of the most written about disorders of childhood (Kauffman, 1983). A wide variety of terms have been used to refer to this disorder; it is now termed Attention-deficit Hyperactivity Disorder (ADHD), according to the Diagnostic and Statistical Manual of Mental Disorders-III-R (DSM-III-R) (American Psychiatric Association, 1987). DSM-III-R states that there are three essential features of ADHD. Those are in-attention, impulsiveness, and hyperactivity. According to DSM-III-R, impulsiveness is evidenced in the classroom by not sticking with tasks sufficiently to finish them and by having difficulty organizing and completing work correctly. Impulsiveness is demonstrated by blurting out answers to questions before they are completed, making comments out of turn, failing to wait one's turn in group tasks, failing to heed directions fully before beginning to respond to assignments, interrupting the teacher during a lesson, and interrupting or talking to other children during quiet periods. In the home, impulsiveness is expressed by interrupting or intruding on other family members and by accident-prone behavior, such as grabbing a hot pan from the stove or carelessly knocking over a pitcher.

Impulsiveness is one of the three main components for a clinical diagnosis of Attention-deficit Hyperactivity Disorder. Therefore, one would expect that adolescents diagnosed ADHD would behave impulsively in a self-control experiment. The present experiment is an attempt to investigate this hypothesis.
Methods

Subjects

The subjects were adolescent males diagnostically labelled Attention-deficit Hyperactivity Disorder. The subjects' ages were 11 years, 14 years, and 14 years. All three subjects lived in a residential care facility for emotionally and/or behaviorally impaired boys and girls. Subjects were selected on the basis of being labelled ADHD by the consulting psychiatrist, and being scheduled for a medication holiday. Informed consent to participate in the study was obtained from the legal guardian of each subject. Approval by Western Michigan University's Human Subjects Institutional Review Board was also obtained.

Apparatus

The study was conducted in a room in one of the housing units of the residential facility. The room contained only a desk, on which the apparatus was placed, and chairs for the subject and experimenter. The experimental console was a wooden box 73 cm wide, 67 cm deep, and 80 cm high. The front of the console contained two lighted buttons, and a hole for coin delivery. The buttons were alternately illuminated red and green, and associated with varying reinforcer amount and delay. During periods of reinforcer access, pennies were dropped out of the hole. The experimenter timed the duration of the delay period with a stop watch, and provided access to the reinforcer by dropping pennies into a copper tube which led out of the hole.

Procedures

Each trial began with the experimenter reading the following instructions to the subject.
Your task is to earn pennies by pushing either the green disk or the red disk. When the red and the green lights come on you may push either disk. Do not push both. Then both lights will go out and the pennies will drop out of the hole. When the time for getting pennies is up the red and green lights will both come on again, and you will be able to choose again. Please stay in your seat until I tell you that we are finished. If you have a watch, please let me hold it for you until we are finished for the day. Don't ask me any questions because I can't tell you anything more.

Each session began with four forced trials. During forced trials, either the red or the green disk was illuminated. Red was correlated with the initial smaller delay and the smaller reinforcer and green was correlated with the initial larger delay and larger reinforcer. Correlation of the red and green disks with the larger and smaller reinforcer varied from session to session, but not within sessions. During a forced trial only, one of the disks was illuminated. The subject could push either disk; however, only pushing the illuminated disk produced pennies. The red disk was illuminated in two of the forced trials and the green disk was illuminated in the other two forced trials. The purpose of the forced trials was to ensure that the subject came in contact with the delays and duration of reinforcer access correlated with both alternatives.

Choice trials were identical to forced trials except that both stimuli were presented. Each session consisted of twenty choice trials. In these trials, the magnitude and delay of reinforcement depended on the stimulus that the subject chose. The stimulus was selected by the subject's pressing either the green or the red disk. As soon as one of the disks was pressed, both disks went dark, and the delay period associated with that stimulus began. When the duration of the waiting period was up, the number of pennies associated with that stimulus (and delay) was delivered. All trials were separated by an intertrial interval (ITI) in which all the lights remained extinguished, and the apparatus was inoperable. For all trials, a minimum ITI of 10 s was arranged. This value was used for all trials unless the larger delayed reinforcer was selected. When this occurred, the ITI following a trial with the larger reinforcer selected was 10 s, but if the smaller reinforcer was selected, the delay associated with
the larger reinforcer was added to the ITI. This procedure was used to ensure that the overall rate of reinforcement was not indirectly affected by the delay value. Pennies served as the reinforcer throughout the study. One penny was always correlated with the smaller delay, and three pennies were always correlated with the larger delay. The smaller reinforcer was delivered immediately after a response, and the larger reinforcer was delayed by increasing amounts. If the subject chose the larger, more delayed reinforcer in all trials of a session 60 cents could be earned.

Delays to the larger reinforcer (three pennies) consecutively increased by intervals of 5 s when the criterion for increase was met. The criterion for increase in delay was 10 consecutive trials within a session with the larger reinforcer being chosen, or when the larger reinforcer was chosen in 90% of the trials within a session. For example, if the subject chose the larger reinforcer in trials 1,2,3,4,5,7,8,9,10,11,12,14,15,16,17,18,19, and 20, but chose the smaller reinforcer on trials 6 and 13, the subject would not meet the criterion for increase according to ten consecutive trials with choice of the larger reinforcer. However, the subject would meet criterion for 90% of trials in which the larger reinforcer was selected. Thus, the next experimental session would begin with a delay to the larger reinforcer of 5 s greater than the delay that was in effect the previous session. This criterion was chosen to allow delay times to increase within a session, rather than selecting a criterion which would only allow delay increases from session to session.

Results

Reliability data were collected in 25% of the trials. The data recorded by the independent observer agreed perfectly with the data collected by the primary experimenter. Tables 1, 2, and 3 show experimental conditions for each subject. The
The tables display the percent of trials in which the larger reinforcer was selected at each delay.

### Table 1
Percent of Trials in Which the Larger Reinforcer was Selected at Each Specific Delay Period for Subject MD

<table>
<thead>
<tr>
<th>Delay</th>
<th># of trials</th>
<th># larger Sr chosen</th>
<th># smaller Sr chosen</th>
<th>% larger Sr chosen</th>
</tr>
</thead>
<tbody>
<tr>
<td>5s</td>
<td>28</td>
<td>20</td>
<td>8</td>
<td>71</td>
</tr>
<tr>
<td>10s</td>
<td>16</td>
<td>16</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>15s</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>20s</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>25s</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>30s</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>35s</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>40s</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>45s</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>50s</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>55s</td>
<td>16</td>
<td>13</td>
<td>3</td>
<td>81</td>
</tr>
<tr>
<td>60s</td>
<td>19</td>
<td>16</td>
<td>3</td>
<td>84</td>
</tr>
<tr>
<td>65s</td>
<td>19</td>
<td>18</td>
<td>1</td>
<td>95</td>
</tr>
</tbody>
</table>

### Table 2
Percent of Trials in Which the Larger Reinforcer was Selected at Each Specific Delay Period for Subject CB

<table>
<thead>
<tr>
<th>Delay</th>
<th># of trials</th>
<th># larger Sr chosen</th>
<th># smaller Sr chosen</th>
<th>% larger Sr chosen</th>
</tr>
</thead>
<tbody>
<tr>
<td>5s</td>
<td>41</td>
<td>27</td>
<td>14</td>
<td>66</td>
</tr>
<tr>
<td>10s</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>15s</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>20s</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>25s</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>30s</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>35s</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>40s</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>45s</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>50s</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>55s</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>60s</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>
Some variability was seen between subjects; however, each subject showed more self-control than impulsiveness in all sessions. Subject CB showed 100% choice of the larger reinforcer at delays of 90 s. Subject MD showed 95% choice of the larger reinforcer at delays of 65 s, and subject KB showed 94% choice of the larger reinforcer.
at delays of 70 s. Delay periods varied between subjects due to the fact that some subjects met the criterion for increase in delay time more rapidly than did other subjects.

Discussion

The results of the present experiment show that the subjects displayed more self-control than previously seen in nonhumans, children, and mentally impaired subjects. In four studies using children and mentally impaired subjects (Burns & Powers, 1975; Mischel et al., 1972, Sonuga-Barke, Lea, & Webley, 1989b; Ragotzy et al., 1988), these subjects chose the smaller less delayed reinforcer when delays to the larger reinforcer were 35 s or less. The subjects in the present study all chose the larger delayed reinforcer when delays were 65 s or greater. The results of this experiment, when viewed as a part of the entire existing literature on self-control, would further suggest that human subjects roughly 9 years old or less tend to behave impulsively like nonhumans, while human subjects above this age most generally display self-control (Sonuga-Barke et al., 1989b).
CHAPTER III

REVIEW OF SELF-CONTROL LITERATURE

An expansive body of literature on self-control exists. Many different branches of psychology have investigated self-control using various methods. Therefore, it is critical that the scope of the review is defined. Only studies which assessed self-control in terms of delay of reinforcement will be discussed, and studies will be discussed in terms of the behavioral paradigm, rather than methods used by other branches of psychology. The studies chosen for review will be explorative in nature, rather than those which attempt to teach self-control.

As noted previously, self-control research has been conducted with various subject types. The literature can be broken down into three categories based on the characteristics of the subjects: nonhumans, children and mentally impaired humans, and adult humans. Nonhumans, children and mentally impaired subjects in general display impulsive behavior. Adult human subjects generally display self-control. Tables 4, 5, and 6 provide pertinent information about several studies, and are broken down in terms of the characteristics of subjects mentioned above.
<table>
<thead>
<tr>
<th>Study</th>
<th>Subject</th>
<th>Reinforcer</th>
<th>Procedure</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rachlin, &amp; Green (1972)</td>
<td>pigeons; 80% free feeding</td>
<td>grain</td>
<td>concurrent schedules</td>
<td>when offered a choice between a small immediate reward &amp; a large reward delayed 4s, pigeons behaved impulsively</td>
</tr>
<tr>
<td></td>
<td>weight</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fantino (1966)</td>
<td>pigeons; 80% free feeding</td>
<td>grain</td>
<td>concurrent schedules</td>
<td>subjects behaved impulsively, selecting a small reward followed by extension, rather than wait for the larger reward</td>
</tr>
<tr>
<td></td>
<td>weight</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Navarick, &amp; Fantino (1976)</td>
<td>pigeons; 80% free feeding</td>
<td>grain</td>
<td>concurrent schedules</td>
<td>pigeons consistently chose the smaller, less delayed reward but through a commitment procedure preference for the larger reward increased</td>
</tr>
<tr>
<td></td>
<td>weight</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mazur &amp; Logue (1978)</td>
<td>pigeons; 80% free feeding</td>
<td>grain</td>
<td>concurrent schedules</td>
<td>an extensive fading procedure can increase self-control in pigeons</td>
</tr>
<tr>
<td></td>
<td>weight</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 4--Continued

<table>
<thead>
<tr>
<th>Study</th>
<th>Subjects</th>
<th>Reinforcer</th>
<th>Methods</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logue, Rodriguez, Pena-Correal &amp; Mauro (1980)</td>
<td>pigeons; 80% free feeding weight</td>
<td>grain</td>
<td>concurrent schedule</td>
<td>pigeons exposed to a fading procedure increased choice of the larger, delayed reward; control subjects behaved impulsively</td>
</tr>
</tbody>
</table>

Table 5

Self-Control Studies Using Children and Mentally Impaired Subjects

<table>
<thead>
<tr>
<th>Study</th>
<th>Subjects</th>
<th>Reinforcer</th>
<th>Procedure</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burns &amp; Powers (1975)</td>
<td>males, ages 9 &amp; 10 years for money</td>
<td>tokens exchangeable</td>
<td>concurrent schedules;</td>
<td>both subjects preferred the smaller reinforcer at delays of 32s</td>
</tr>
<tr>
<td>Mischel, Ebbesen, &amp; Zeiss (1972)</td>
<td>ages 3 to 5 snacks</td>
<td>edible</td>
<td>discrete trials;</td>
<td>subjects terminated wait in less than one min.</td>
</tr>
<tr>
<td>Sonuga-Barke, Lea, &amp; Webley (1989)</td>
<td>females, ages 4, 6, 9, &amp; 12</td>
<td>tokens exchangeable for sweets</td>
<td>discrete trials; no ITI</td>
<td>6 &amp; 9 yr olds behaved impulsively, 12 yr olds maximized, 4 yr. olds inconclusive</td>
</tr>
<tr>
<td>Ragotzy, Blakely, Poling (1988)</td>
<td>mentally retarded adolescents</td>
<td>pieces of cereal</td>
<td>discrete trials</td>
<td>all subjects preferred smaller reward at delays of 30s</td>
</tr>
<tr>
<td>Study</td>
<td>Subjects</td>
<td>Reinforcer</td>
<td>Procedure</td>
<td>Results</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-------------------</td>
<td>------------------</td>
<td>----------------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Millar &amp; Navarick (1984)</td>
<td>undergrads</td>
<td>video games</td>
<td>discrete trials</td>
<td>40% of subjects behaved impulsively</td>
</tr>
<tr>
<td>Logue, Pena-Correal Rodriguez, &amp; Kabela (1986)</td>
<td>females ages 18 to 30</td>
<td>points exchangeable for money</td>
<td>discrete trials exp. 1 concurrent schedules exp.2-5</td>
<td>subjects consistently showed self-control under all conditions</td>
</tr>
<tr>
<td>Buskist &amp; Miller (1981)</td>
<td>undergrads</td>
<td>nuts</td>
<td>concurrent schedules</td>
<td>subjects maximized reinforcement, thus displaying self-control</td>
</tr>
<tr>
<td>Navarick (1986)</td>
<td>undergrads</td>
<td>projection slides of famous people</td>
<td>discrete trials</td>
<td>subjects preferred reinforcer when amount &amp; delay varied &amp; maximized reinforcement when ITI was removed</td>
</tr>
<tr>
<td>King &amp; Logue (1990)</td>
<td>undergrads</td>
<td>points exchangeable for money consummatory response</td>
<td>concurrent schedules</td>
<td>subjects showed self-control when value varied, but exhibited less self-control when the response was eliminated</td>
</tr>
<tr>
<td>Navarick (1982)</td>
<td>undergrads</td>
<td>termination of white noise</td>
<td>discrete trials</td>
<td>subjects acted impulsively as the delay to the larger reinforcer increased</td>
</tr>
</tbody>
</table>
Table 6—Continued

<table>
<thead>
<tr>
<th>Study</th>
<th>Subjects</th>
<th>Reinforcer</th>
<th>Methods</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solnick,</td>
<td>undergrads</td>
<td>termination</td>
<td>discrete trials</td>
<td>90% chose the smaller less delayed reinforcer 70% of the trials</td>
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<td>Kannenberg, Eckerman,</td>
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<td>of white noise</td>
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<td>&amp; Waller (1980)</td>
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Nonhuman Subjects

Nonhuman subjects generally behave impulsively. Pigeons, under a variety of conditions, select the immediate, small reinforcer (Ainslie, 1974), and only through extensive training may come to select the delayed, large reinforcer (Fantino, 1969). Rachlin and Green (1972) studied self-control in pigeons. They used a concurrent schedules procedure. When offered a choice between a small, immediate reinforcer (2 s access to grain) and a larger reward (4 s access to grain) delayed by 4 s, the pigeons invariably behaved impulsively. Pigeons behave impulsively in all self-control studies except where extensive fading procedures have been employed (Fantino, 1960; Mazur & Logue, 1978).

Mazur and Logue (1978) had pigeons choose between immediate 2 s access to grain or 6 s access delayed by 6 s. The four control subjects were exposed to this condition initially, while the four experimental subjects first received a condition where both reinforcers were delayed by 6 s. Delays to the smaller reinforcer (2 s access to grain) were then gradually decreased to zero over more than 11,000 trials for subjects in the experimental group. Subjects in the experimental group displayed self-control significantly more often than subjects in the control group. Table 4 presents data on the five studies reviewed. These studies support the conclusion that pigeons behave impulsively except where extensive fading procedures have been employed.
Children and mentally impaired subjects generally show impulsive behavior. Mischel et al. (1972) conducted a study to assess the effects of cognitive distraction techniques on self-control in children three to five years old. Mischel's et al. cognitive distraction techniques are inappropriate for a behavioral review. However, the data from the control subjects, who were not exposed to distraction procedures, are of interest. Mischel et al. arranged procedures to allow the children to choose between a smaller, less delayed reward, or a larger reinforcer delayed up to fifteen minutes. The children could terminate the waiting period at any time and receive the smaller reward. They found that the children consistently selected the smaller reward after waits of less than one minute.

Burns and Powers (1975) conducted a study to assess the effects of a commitment model on children's self-control behavior. Two males, age nine and ten years, served as subjects. Mexican coins exchangeable for money served as the reinforcer. Procedurally, Burns and Powers arranged two concurrent schedules of reinforcement. Selecting the left response key in the initial link illuminated both a green and red response key, while selection of the right response key in the initial link activated only the green key. The red key was correlated with the smaller, immediate reward, while the green key was correlated with the larger, delayed reward. Burns and Powers found that as the delay to reinforcement increased the subjects' preference for the left alternative in the terminal link increased, and preference for the immediate reward in the terminal link increased. Thus, the children didn't utilize the right alternative which was considered a self-control response because it avoided the temptation of the immediately available, smaller reward.

Sonuga-Barke et al. (1989b) studied the effects of age on self-control in children. Girls age 4, 6, 9, and 12 years served as subjects. Tokens exchangeable for
sweets and toys served as the reinforcer. All subjects were exposed to increasing delays to the larger of two rewards, with no ITI accompanying the smaller reward. Thus, children could maximize reinforcement by choosing the longer delay when it was relatively short, but choosing the shorter delay when the longer delay was at its highest values. Their results showed that six and nine year olds were insensitive to changes in pre-reward delays, and always chose the larger reward, thus not maximizing reinforcement. All twelve year old subjects showed maximization, and the performance of four year olds was ambiguous.

Ragotzy et al. (1988) examined self-control in mentally retarded adolescents. Ragotzy's et al. results with their subjects, mentally retarded adolescents, were similar to those of children without disabilities in that they also chose the smaller alternative when there was a significant delay to the larger reinforcer.

Thus it appears that children age 9 and under and mentally impaired subjects behave impulsively, while children older than 12 years show self-control.

Adult Human Subjects

Logue et al. (1986) conducted a series of five experiments to examine self-control in adults, using various procedures. Subjects displayed self-control in all five conditions. Points exchangeable for money served as the reinforcer. Experiment 1 used a discrete trial procedure, while experiments 2 through 5 used concurrent schedules. During experiment 1, reinforcer access was varied between 8 s and 12 s and delays were set at .05 s for the smaller reinforcer, and 120 s for the larger reward. In experiments 2 through 5 reinforcement amount and delay varied together, and varied separately using independent variable interval 30 s variable interval 30 s concurrent schedules and a 3 s changeover delay. "Together, the experiments consistently showed that relative reinforcer amount controlled the subjects' behavior more than did
relative reinforcer delay; the subjects frequently chose the larger, more delayed reinforcer, over the smaller, less delayed reinforcer" (p. 169). Through this pattern of responding subjects maximized overall reinforcement, thus displaying self-control in all conditions.

Millar and Navarick (1984) and Navarick (1986) examined the effects of reinforcer type on self-control in undergraduates. Millar and Navarick (1984) used video game playing as a positive reinforcer; and Navarick (1986) used viewing slides of famous personalities as a positive reinforcer. Millar and Navarick stated that they chose video game playing as a reinforcer because its popularity suggests that it is a strong reinforcer; video game playing requires interaction with a stimulus for a specific period of time; and video game playing is at least partially intrinsically reinforcing. Millar and Navarick believe that these qualities make video game playing more similar to the reinforcers usually used with nonhumans. Navarick (1986) chose viewing slides of famous personalities as his reinforcer because their abundance in print media suggest that they are highly reinforcing, and slides eliminate several complicating factors inherent in video games (i.e., individual skill level, and changes in games difficulty produced by game performance). These studies were an attempt to replicate the impulsiveness exhibited by adult subjects when termination of white noise served as a negative reinforcer (Navarick, 1982; Solnick et al. 1980). However, in both of these studies adult humans showed more self-control than impulsiveness. When video games served as the reinforcer, 40% of the subjects selected the smaller, less delayed reinforcer, thereby demonstrating the highest level of impulsiveness shown in adults using positive reinforcement. When projection slides served as the reinforcer, subjects preferred the larger, delayed reinforcer in the majority of trials, and when the ITI was eliminated subjects chose the smaller, less delayed reinforcer when it resulted in overall maximization of reinforcement.
As mentioned above, adult humans have shown impulsive behavior under one condition: when termination of white noise served as a negative reinforcer (Navarick, 1982; Solnick et al., 1980). Solnick et al. (1980) were the first to investigate the effects of negative reinforcement on self-control. They found that undergraduates more frequently chose the smaller, less delayed reinforcer, 90 s noise-off, 90 s noise-on, rather than the larger, more delayed reinforcer, 60 s noise-on, 120 s noise-off. Ninety percent of the subjects acted impulsively on 70% of the trials. Self-control was slightly increased by use of a commitment model in which subjects chose before the onset of white noise.

Navarick (1982) found similar results using undergraduates and termination of white noise. Navarick's study differed from Solnick's et al. (1980) in two significant ways. Solnick et al. had their subjects do arithmetic problems during the sessions, in an attempt to make white noise more aversive. Navarick eliminated this procedure. The second distinguishing feature is that Navarick adjusted noise level for each subject. Solnick used one noise level for all subjects. Despite these procedural differences, Navarick obtained very similar results. The majority of subjects preferred the smaller reinforcer when delay to the larger reinforcer was 40 s, thereby behaving impulsively.

Thus, adult human subjects displayed self-control in all studies using positive reinforcement, and only behave impulsively when termination of white noise served as a negative reinforcer.

This review suggests that the data are fairly consistent within subject groups, but varies greatly between groups. Several explanations have been proposed as to why difference occur between subject groups. The remainder of this paper will consider three of the most frequently discussed explanations.
CHAPTER IV

EXPLANATIONS FOR VARYING RESULTS

Verbal Behavior

Verbal behavior appears to be one of the most reasonable explanations for differences between subject groups. Several of the studies reviewed above support this position. Three other studies not yet discussed also will be presented here.

Sonuga-Barke et al. (1989b) examined the effects of age on self-control (reviewed above), and stated that the differing self-control behavior found in their subjects of various ages could be based on verbal behavior. They asked each subject at the end of each experimental session, "Which block did you like best?" The 4-year-old subjects all said that they preferred the large, delayed reinforcer. However, in most cases these subjects selected the small, immediate reward. Twelve-year-old subjects stated that they preferred the small, immediate reward in sessions when they actually chose that reinforcer. Thus, the self-reports of 12-year-olds were consistent with their behavior, and the self-reports of 4-year-olds were not. Sonuga-Barke et al. stated, "these data suggest that the 12-year-olds' behavior was determined by a verbally expressible estimate of rate of reward, whereas that of the 4-year-olds tended to come under the control of delay in some way that was not mediated by language" (p. 83). Several other studies previously discussed appear to support this conclusion. For example, in the Ragotzy et al. (1988) study, mentally retarded adolescents with little verbal behavior served as subjects and behaved impulsively.

Miller, Weinstein, and Karnoil (1978) and Toner and Smith (1977) examined the effects of age and overt verbalizations on children's ability to delay gratification. In
both studies, children were given explicit instructions to make an overt statement during the wait to the larger reward. Miller et al. (1978) found that task oriented statements, e.g., "I'm waiting for the _____ (preferred reward)," facilitated delay behavior in both kindergarten and third grade children. In the control condition where no verbalizations were made, third grade children were better able to endure the delay period than kindergarten children. Toner and Smith (1977) found that overt verbalizations by children during the waiting period significantly influenced their duration of self-imposed delay maintenance. The content of the verbalization was also a critical determinant. For children at all age levels, the verbalization that focused on the delayed reward resulted in less delay maintenance than did the verbalization about the goodness of waiting. Therefore, it appears that children who express rule statements about the goodness of waiting exhibit greater self-control than subjects who do not make such statements.

Bentall, Lowe, and Beasty (1985) investigated the effects of verbal behavior on sensitivity to schedules of reinforcement. This study did not use a self-control paradigm; however, the results are relevant to the effects of verbal behavior on self-control. Responding on a fixed interval schedule ranging in value from 10 s to 70 s was examined for children of several age groups. Bentall et al. found that behavior of preverbal infants (6 mon. to 1 1/2 years) resembled responding of other animal species. Children ages 5 to 6 1/2 and 7 1/2 to 9 years exhibited responding patterns typical of adult humans. Bentall et al. (1985) concluded,

The evidence supports the suggestion that the development of verbal behavior greatly alters humans operant performance and may account for many of the differences found between human and animal learning. (p. 165).
Influence of Instructions

Closely related to the overall concept of verbal behavior, is the specific effect of instructions. Several studies on self-control have hypothesized that instructions given to the subjects may play a role in subjects' displaying impulsivity or self-control.

In general, instructions have been shown to affect human responding. Matthews, Shimoff, Catania, and Sagvolden (1977) and Shimoff, Cantania, and Matthews (1981) investigated this phenomenon. Matthews et al. (1977) found that even minimal instructions provided by a demonstration sometimes generated high-rate responding under conditions that otherwise maintained lower rates of responding. Along the same line, Shimoff et al. (1981) found that low-rate responding established by shaping is generally sensitive to changes in contingencies, but that instructions may produce low-rate responding insensitive to contingencies. Matthews et al. (1977) concluded,

The usual effectiveness of instructional control over human behavior is the product of extensive history of differential reinforcement for following instructions. Because instructions are often used for supplementing weak environmental contingencies or supplanting counterproductive ones, it should not be surprising that instructions may acquire the power to override reinforcement contingencies. (p. 465)

Instructions in self-control studies range from very explicit directions to minimal guidance. For example, Buskist and Miller (1981) informed their subjects prior to the beginning of the experiment that their goal was to obtain as much food as possible from a vending machine, and that the person who obtained the most food at the end of a five day period would receive a cash bonus--as opposed to Ragotzy et al. (1988) who simply instructed subjects to "pick one."
A third explanation for the differences in self-control between subjects is reinforcer type. Logue et al. (1986) offered reinforcer type as one possible alternative for obtaining results with adult human subjects that differ from results with nonhuman subjects. Logue et al. state that all the studies they addressed in the introduction to their paper used pigeons as subjects, and that the pigeons were food deprived, and therefore, it is difficult to find any positive reinforcer that would be equally motivating to adult human subjects.

The studies from the nonhuman literature reviewed in this paper are similar to those discussed by Logue et al. (1986). Five primary studies were reviewed in the nonhuman subjects literature (see Table 1). All five of these studies used pigeons as subjects, and these pigeons also were all maintained at 80% of their free feeding weights. Five studies also were reviewed in the adult human subjects literature employing positive reinforcement. Only one of these five studies used a primary reinforcer. Buskist and Miller (1981) used nuts as a reinforcer, but their subjects still exhibited self-control. Obviously, the human subjects used by Buskist and Miller were not food deprived to the extent that the pigeons in nonhuman studies were.

Studies which employ termination of white noise as a negative reinforcer also appear to support the conclusion of reinforcer type as an explanation for differing results. These experiments are the only experiments where adult human subjects have consistently shown impulsive behavior (Navarick, 1982; Solnick et al., 1980). Aversive stimulation has been shown to be an effective motivational variable or establishing operation (Skinner, 1957; Michael, 1982). In cases where termination of white noise serves as the reinforcer, it appears that white noise is an aversive condition that would sufficiently motivate adult human subjects to chose the smaller, immediate reinforcer, rather than waiting for the larger, but delayed reward, much the same as
nonhumans behave when grain serves as the reinforcer, and food deprivation serves as the establishing operation.
Appendix A

HSIRB Approval Form
Date: August 2, 1990
To: Shannon Swick, Psychology
From: Mary Anne Bunda, Chair
Re: HSIRB Project Number 90-04-18

This letter will serve as confirmation that we have received the revised informed consent with the new reinforcer for your research protocol, "Impulsiveness and Attention-deficit Hyperactivity Disorder." This change in your research project has been approved.

xc: Alan Poling, Psychology
BIBLIOGRAPHY


