

**DIMENSIONAL IMPLICIT MEMORY PRIMING DEFICITS IN
YOUNG ADHD ADULTS**

A Senior Scholars Thesis

by

CHRISTOPHER GEORGES TATMAN

Submitted to the Office of Undergraduate Research
Texas A&M University
in partial fulfillment of the requirements for the designation as

UNDERGRADUATE RESEARCH SCHOLAR

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Approved by:

Research Advisor:
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ABSTRACT

Dimensional Implicit Memory Priming Deficits in Young ADHD Adults. (April 2010)

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The experiment explored the difference between production and identification processes and conceptual and perceptual processes in long-term implicit memory. The first phase consisted of prescreening ADHD (Attention Deficit Hyperactivity Disorder) and non-ADHD Texas A&M undergraduate students. The second phase consisted of a study task and a filler task. The third phase consisted of four tests containing two of the four processes. The participants performed a category verification test (conceptual-identification cross), category generation test (conceptual-production cross), a flashing words test (perceptual-identification cross), and a stem completion test (perceptual-production cross). No statistically significant difference in priming was found between ADHD and non-ADHD. However, looking at the sample as a whole (ADHD and non-ADHD combine), there was significant priming in the category generation test, flashing words test, and the stem completion test but not in the category verification test.

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I would like to begin by thanking Dr. Terry Barnhardt for being my mentor and friend. He took me under his wing and his patience knew no bound. I'm deeply grateful for his guidance during my studies. His invaluable counsel will be a source of references for many years to come.

I would also like to thank my parents, Anne and Larry Chesnut, for cheering me on during all these years and keeping me focused when distraction was tempting. They reminded me that a goal is always reached one step at the time.

NOMENCLATURE

ADHD	Attention Deficit Hyperactive Disorder
CAARS	Conners' Adult Rating Scales
CG	Category Generation
CV	Category Verification
CV – M	Category Verification – Matching
CV – NM	Category Verification – Non-Matching
PAS	Personal Attitude Scale
PID	Perceptual-Identification
RT	Reaction Time
SC	Stem Completion

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CHAPTER I

INTRODUCTION

Memory can be subcategorized into explicit (declarative) and implicit memory. Explicit memory can be described as memory consciously being retrieved (Graf & Schacter, 1985). For example, when professors give exams, students utilize their explicit memory to answer the questions. The students would have to be presented with information, and then consciously try to retrieve the answers to the questions through their past experiences.

Implicit memory can be described as memory that is retrieved subconsciously (Graf & Schacter, 1985). Many behaviors exerted by people are learned throughout their lifetime. However, while they perform different behaviors people usually do not have to consciously think of what they are doing. An example of subconscious behavior exerted through implicit memory is the ability to tie ones shoes or the ability to ride a bicycle. In comparison to healthy adults, elderly populations show impairments in explicit memory but no significant impairments in implicit memory (Fleischman & Gabrieli, 1998).

Implicit memory can be further divided into four dimensions: perceptual, conceptual, identification, and production.

This thesis follows the style of *Journal of Experimental Psychology: Learning, Memory, and Cognition*.

Perceptual vs. conceptual distinction

The perceptual priming of implicit memory can be described as a person's ability to remember perceptual information (visual or auditory) from past-presented stimuli (Gabrieli et al, 1995; Blaxton, 1989; Roediger, 1990). For example, in the flashing words task participants are asked to say out loud words that are presented for a short duration of time (e.g. 25 ms).

The conceptual priming of implicit memory can be described as the ability to remember items according to stimulus meaning (Vaidya et al, 1999). An example of a conceptual priming task is the ability to insert words correctly into their corresponding category (e.g. Chair with furniture).

Identification vs. production distinction

Identification priming involves the direct identification of stimuli. In these kinds of tasks, each presentation has only one correct response. For instance, if a person was presented with a word, and then asked to read that word, there would be only one correct answer.

Production priming involves responses that are generated by the participant. These kinds of tasks allow for many possible responses, but are usually looking for target responses. For example, if a person was asked to name items that they consider furniture, they should be able to give more than one answer. Alzheimer disease patients

show intact performance on identification tasks, but impairments in production tasks (Sullivan et al., 1995; Balota & Ferraro, 1996; Carlesimo, Fadda, Marfia, and Caltagirone, 1995; Monti et al., 1996).

Present study

Burden and Mitchell's (2005) study found children with ADHD exhibit a conceptual implicit deficit; however children with ADHD retained perceptual implicit memory in comparison with non-ADHD young adults. Murphy (2009) further Burden and Mitchell's (2005) study and performed four implicit memory tests with identification or production components. In other words, Murphy (2009) implemented a test with a conceptual-production cross, a test with a conceptual-identification cross, a test with a perceptual-production cross, and a test with a perceptual-identification cross. The study found no significant distinction between ADHD and non-ADHD young adults for any of the tests. Figure 1 shows the tests used by Murphy. The red "x" depicts the two tests Burden and Mitchell performed in relation to the four crosses implemented by Murphy.

	Identification	Production
Perceptual	X Perceptual- Identification	Perceptual- Production
Conceptual	Conceptual- Identification	X Conceptual- Production

Figure 1. Dimensional Implicit Memory Cross (Murphy, 2009)

The present study implemented three differences that seek to improve Murphy's (2009) study. The first change was the removal of one of two of the filler tasks to decrease the delay between the study task and the implicit memory tests. We hope that by removing one of the filler tasks the participants' ability to retain the information from the study task will be sufficient enough to show an increase in priming for the memory tasks. However, one filler task will remain in the study in order to refrain the participants from continually thinking about the words in the study task. The second change was the lengthening of duration of presentation of the stimuli in hopes that by giving the participants more time to respond, they will answer more frequently. The last change was to maintain a constant arrangement of implicit memory tests across all of the participants in order to avoid cross talk between the memory tests. We decided the more closed-ended tasks should precede the more open-ended tasks so that words that were generated by the participants were not used in other tasks. With these changes made, we hope to more accurately see a priming deficiency in the production dimension of implicit memory.

CHAPTER II

METHOD

Participants

A total of 42 introductory psychology students between the ages of 18 and 24 years of age (21 were female, 21 were male) were tested.

An ADHD prescreening measure was used to ensure correct participant placement into either the ADHD (N=23) or the non-ADHD (N=19) group.

CAARS

An online version of the self-report screening form (CAARS-S:SV) of the The Conners' Adult ADHD Rating Scales (CAARS) was utilized in order to assess ADHD criterion (inattention, hyperactivity, and impulsivity) as listed in the DSM-IV. The CAARS-S:V is a 10 minute screening process with a 9 item inattentive symptoms subscale, a 9 item hyperactive-impulse symptoms subscale, and a 12 item total ADHD symptoms subscale (30 item test overall). The CAARS-S:V uses a four point likert scale where the participant's own experiences are ranked from never occurring (0) to happening less frequently (1) to more than average (2) to more than average (3). The participant's score was converted into a standard t-score in which the higher the score the more likely the participant had ADHD. Participants that fell into the 66th percentile were placed into the ADHD group. Participants that fell into the 33rd percentile were placed in the non-ADHD group.

One order was designed to avoid cross-talk between the tasks specifically chosen so the most close-ended tasks occurred first and the most open-ended task ended last after the initial study and filler tasks. Thus, the order of the experiment was the study task, a filler task, the category verification task, the category generation task, the sentence completion task, and then the perceptual identification task all of which were created in E-Prime.

Materials

The experiment had a total of 144 stimuli that were specifically chosen so that each stimulus had their own unique category and their own three-letter stem. Seventy-two of the stimuli were used in the study task and were later distributed so that each of the four memory tasks had eighteen studied stimuli. The seventy-two stimuli that were not used in the study task were also distributed so that each of the four tasks had eighteen stimuli that were not studied. Thus, each memory task had eighteen studied stimuli and eighteen stimuli that were not studied, for a total of thirty-six stimuli per task.

Titration

In this task, the participant was instructed to say out loud words that were presented for an extremely short duration that ranges from (15 ms, 25 ms, 35 ms, and 45 ms). There was an initial blank screen of 150 ms, followed by a 595 ms nine character mask which consisted of the pound symbol, followed by the presentation of the stimuli which ranged in duration (15 ms, 25 ms, 35 ms, and 45 ms), followed by another 595 ms mask. There

was a 1245 ms blank screen in between each 2nd mask and 1st mask. There was a total of 32 stimuli presented in this task.

Study task

In this task, the participant was instructed to determine whether they thought a word's meaning was pleasant or unpleasant. If the participant thought the word was pleasant, they were instructed to press the "L" key. If the participant thought the word was not pleasant or neutral, they were instructed to press the "D" key. Each blank screen that preceded each stimulus lasted for 750 ms. Each beep that preceded each stimuli lasted for 25 ms. Each stimulus was then presented on the screen for 1500 ms.

Filler task

A filler task was presented so the participants avoided thinking of the studied stimuli presented in the pleasantness task. In the filler task, the participants were instructed to type the entirety of fragmented famous names (e.g. Ta_l_r Sw_ft) for three minutes.

CV

In the category verification task, the participant was instructed to verify whether a presented word fit correctly into a presented category. If the word did fit the category, then the participant was instructed to press the "L" key. If the word did not fit the category, then the participant was instructed to press the "D" key. A total of 36 trials were presented. Eighteen words came from the study task; nine were congruent while

nine were non-congruent with their presented category. Eighteen words that were presented were not studied; nine were congruent and nine were non-congruent with their presented category. A blank screen was presented lasting for 150 ms after an initial 25ms beep. The target word was presented above the given category in the center of the screen for 1850 ms. Another blank screen was presented for 250 ms followed by a 25 ms beep.

CG

In the category generation task, the participant was instructed to say aloud a word that fit a presented category. Because a vocal response was desired and an audio-recording device was present there were no time restraints on the response. A total of thirty-six categories were presented, eighteen involving previously studied targets and eighteen targets that were not studied. A 150 ms blank screen was presented after an initial 25 ms beep. The category was then presented for 1850 ms followed with a 250 ms blank screen and a 25 ms beep.

SC

In the stem completion task, the participant was instructed to generate a word from a three-letter stem presented on the center of the screen. Thirty-six stems were presented, eighteen from the study task and eighteen were not studied. A 150 ms blank screen was presented after an initial 25 ms beep. The three-letter stem was then presented for 1850 ms followed with a 250 ms blank screen and a 25 ms beep.

Flashing words

This task was the same as the titration task, except there were four minor changes.

Instead of being presented with words that are flashed for different periods of time (15 ms, 25 ms, and 35 ms), the words were flashed for a constant duration according to their placement by the experimenter from the titration task. The flashing words task is also longer in duration because there are a total of 44 stimuli as compared to the titration task, which had 32 stimuli.

CHAPTER III

RESULTS

Using statistical tests with $p < .05$, a priming analysis was performed on each of the four tests for the ADHD group, non-ADHD group, and in the entire sample (ADHD and non-ADHD combined). Reaction time on only the correct responses for the Category Verification task on both non-matching and matching aspects of the task was also considered.

Looking at the entire sample (ADHD and non-ADHD combined) there is statistically significant priming in the Stem Completion, Category Generation, and Perceptual-Identification (Flashing Words) tasks, but not in the Category Verification task, as indicated in Table 1. Even though there wasn't significant priming in the Category Verification task, there was a difference in accuracy between the non-matching ($M = -.073$, $SD = .200$) and the matching ($M = -.005$, $SD = .127$) aspects of the task for the ADHD population that could possibly show the impulsivity symptom of ADHD.

No statistically significant difference was seen on any of the four tasks in regards to population type (ADHD or non-ADHD). In fact, after performing t-tests all of the t-scores were less than 1.2, and all p-values were greater than 0.25. Also, after analyzing the effect of awareness on performance there was no statistically significant difference

between the three groups: aware but are not retrieving the studied words, aware and are retrieving the studied words, and not aware of the repetition of the studied stimuli.

Table 1. Priming Performance in accuracy as a function of population.

<i>Population</i>	<i>SC</i>			<i>CG</i>			<i>PID</i>		
	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>
ADHD	.135	.118	23	.085	.122	23	.130	.166	23
non-ADHD	.094	.119	19	.079	.160	19	.134	.148	19
Total	.116	.119	42	.082	.138	42	.132	.156	42

<i>Population</i>	<i>CV - nm</i>			<i>CV - m</i>			<i>CV - nm RT</i>			<i>CV - m RT</i>		
	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>
ADHD	-.075	.200	23	-.005	.127	23	25.130	117.530	23	15.370	114.951	23
non-ADHD	.035	.148	19	.018	.100	19	55.973	129.163	19	16.433	104.574	19
Total	-.024	.184	42	.005	.115	42	39.083	122.383	42	15.851	109.049	42

CHAPTER IV

SUMMARY AND CONCLUSIONS

This study explored four dimensional implicit memory crosses in ADHD adults. Burden and Mitchell (2005) found a conceptual implicit memory deficit and intact perceptual implicit memory. Murphy (2009) furthered Burden and Mitchell's study and included the identification and production aspects of implicit memory but found no statistically significant difference between ADHD and non-ADHD adults.

This study implemented three changes on Murphy's study. First a filler task was removed to decrease delay between the study task and the implicit memory tests. The second change was the lengthening of stimuli presentation duration. The third change was the maintenance of arrangement of implicit memory tests so the more close-ended tasks occurred first.

It was hypothesized that a production deficiency in implicit memory will show in individuals with ADHD as compared with individuals without ADHD. However, no statistically significant difference was found between ADHD individuals and non-ADHD individuals on any of the implicit memory tests. There was a difference between the non-matching and the matching aspects of the CV task for the ADHD population which could show the impulsivity symptom of ADHD.

Future research

Removing the filler tasks completely allowing a direct transition from the study task into the implicit memory test could increase priming in all of the implicit memory tests.

Using standard basic categories (e.g. Furniture, Shape) would allow easier priming. A

study dividing the attention of non-ADHD individuals would directly test the

improvements implemented specifically on the implicit memory tests. Also, the addition

of the CPT could increase confidence in the correct placement of individuals into the

ADHD population and the non-ADHD population. The addition of the PAS could

increase the confidence that attention is affecting performance on the implicit memory

tests.

In summary, no significant difference occurred between ADHD and non-ADHD in any

of the four implicit memory tests.

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APPENDIX A

ADDITIONAL PRESCREENING

1. Have you, your parents, or your teachers ever thought about you being tested for ADHD?
2. Have you ever been tested for ADHD?
3. Have you ever been diagnosed with ADHD?
4. If you have been diagnosed with ADHD, did you take ADHD medicine?
5. If you were diagnosed with ADHD in the past, do you currently consider yourself to still have ADHD?
6. Are you currently taking medications for ADHD?

APPENDIX B
AWARENESS QUESTIONNAIRE

1. What do you think was the purpose of the last four tasks you completed? The last four tasks you did were (1) say “yes” if the example was from the category, (2) complete the word beginnings, (3) produce an example for each category, and (4) identify words flashed very quickly.

2. What was your general strategy in trying to produce responses in these tasks?

3. While you were doing any of these tasks, did you notice any relationship between the words that were presented in the second task in the experiment (where you decided whether the meanings of words were pleasant) and the words you saw or said in the last four tasks?

4. If you did recognize a relationship between words in the pleasantness task and words you saw or said in the last four tasks, what was that relationship and in which of the last four tasks did you notice it?

5. At any time during the last four tasks, did you notice whether the words that were displayed (or that you produced) were the same as the words in the pleasantness task?

6. If you noticed that you were saying words from the pleasantness task in any of the last four tasks, did you continue to try to do your best on the task or did you start to try to use the pleasantness words?

7. If you tried to use pleasantness words as responses, in which of the last four tasks did you do this?

8. If you noticed that you were saying pleasantness words in any of the last four tasks, did you become aware of this while you were responding with a particular word? If so, what was that word?

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