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The Effects of DDAVP on Speed of Accessing Long-Term Memory and Incidental Learning in Healthy Male and Female Volunteers

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THE EFFECTS OF DDAVP ON

SPEED OF ACCESSING LONG-TERM MEMORY AND INCIDENTAL LEARNING

IN HEALTHY MALE AND FEMALE VOLUNTEERS

by

Robyn R. Swenson
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This Dissertation, submitted by Robyn R. Swenson in partial fulfillment of the requirements for the Degree of Doctor of Philosophy from the University of North Dakota, has been read by the Faculty Advisory Committee under whom the work has been done and is hereby approved.

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This Dissertation meets the standards for appearance, conforms to the style and format requirements of the Graduate School of the University of North Dakota, and is hereby approved.

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Title   The Effects of DDAVP on Speed of Accessing Long-
             term Memory and Incidental Learning in Healthy Male
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Department   Psychology

Degree   Doctor of Philosophy

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ABSTRACT

The effects of desmopressin acetate (DDAVP), a vasopressin analog, were investigated using a computerized task designed to measure speed of accessing long-term memory at three levels of processing (physically identical decisions, same name decisions and same category decisions), and an unexpected free recall of the words presented.   Forty-one healthy females and forty-three healthy males (age 18-34) intranasally received either 60 ug DDAVP in 0.6 ml of solution or 0.6 ml of saline 20 minutes prior to testing. DDAVP did not affect response time on the computerized task; however, when response time control trials were subtracted from the corresponding cells of the design, DDAVP was found to decrease response times for physically identical decisions only.   In addition, DDAVP increased response times on the response time control task designed to measure the motor component of responding.   Analysis of the error rates suggests a subtle sexually dimorphic effect of the peptide in that DDAVP facilitated accuracy for DDAVP-treated female subjects, but had an adverse effect in regard to error rates for DDAVP-treated male subjects.   No treatment effect was found for incidental learning as measured by unexpected free recall of the words presented during the computer task.

CHAPTER I

INTRODUCTION

Vasopressin is a nonapeptide hormone synthesized in the suprachiasmatic, paraventricular and supraoptic nuclei of the hypothalamus. The peptide is cyclic with a disulfide bridge between positions one and six. From the hypothalamic nuclei, the peptide is transported via axons to the neurohypophysis where it is released into the general circulation. Peripherally, vasopressin functions as a classical hormone. The hormonal functions of vasopressin include: regulation of osmolality, blood pressure, and blood volume (Hadley, 1988). In addition to its effects as a classical hormone, vasopressin is believed to act as a neurotransmitter or neuromodulator within the central nervous system. Exohypothalamic fibers terminating in various brain areas have been localized in rodents (Boer & Swaab, 1983), and it is at brain sites such as the hippocampus that vasopressin may implement its behavioral effects (Smock, Albeck & McMechen, 1990). One of the most studied behavioral effects of vasopressin is its effect on memory (van Wimersma Greidanus, van Ree & de Wied, 1983). Research exploring the effects of vasopressin on memory has employed both non-human and human subjects.

The literature utilizing animal models has included studies of the organizational and activational effects of vasopressin on memory. The term "organizational" refers to the fact that administration of the peptide occurs during critical periods of cell proliferation in the brain. Rats exposed to vasopressin during the prenatal and neonatal periods demonstrate subsequent alterations in learning when trained and tested as adults, presumably by altering the brain systems which modulate memory (Ermisch, Koch & Barth, 1986; Tinius, Beckwith, Preussler & Lee, 1987; Chen, Chen, Liu & Du, 1988; Swenson, Beckwith, Lamberty, Krebs & Tinius, 1990).

Activational studies include all studies in which administration of the peptide occurs when the animal is mature and the brain fully developed. Vasopressin administration has been found to increase resistance to extinction of both passive and active avoidance tasks in the adult male rat (Ader & de Wied, 1972; de Wied & Versteeg, 1979), and to reactivate memory after amnestic treatments (Tinius, Beckwith, Wagner, Tinius & Traynor, 1986). These findings have been viewed as evidence that vasopressin facilitates memory. Vasopressin administration has also been found to facilitate reversal learning of a black/white discrimination (Beckwith & Tinius, 1985; Beckwith, Tinius & Miller, 1987). This has been interpreted as evidence that vasopressin enhanced selective attention. In summary, the results of both activational studies and organizational studies involving animal models suggest that administration of vasopressin modulates memory as well as

attentional processes. Note that these are not independent processes.

Results of studies utilizing these animal models have led researchers to explore the actions of vasopressin or one of its several available analogs (see Table 1) on memory in healthy young adults using several information processing paradigms. Various memory tasks have been employed to assess the effects of vasopressin administration on visual memory, auditory memory, tactile memory, story reproduction, recall of prose and lists of words.

Beckwith, Petros, Kanaan-Beckwith, Couk, Haug and Ryan (1982) assessed the effects of vasopressin on visual memory using a modification of the Benton Visual Retention Test. Sixty micrograms (ug) of Desmopressin acetate (DDAVP) was intranasally administered to 39 healthy, young, adult male subjects (age 18-25). A third group of 15 subjects received no treatment. The interval between administration of DDAVP and the memory test was approximately 25 minutes. Treatment did not affect measures of visual retention.

Snel, Taylor and Wegman (1987) studied the effects of vasopressin on both visual and auditory memory. Twenty male volunteers ranging from 20 to 31 years of age received either increasing daily doses of Desglycinamide-arginine-vasopressin (DGAVP) (0.1, 0.3, 1.0, 3.0 and 10 mg) or a placebo for five consecutive days. Treatment was administered through two puffs of

Table 1

Amino Acid Sequence of Vasopressin and Vasopressin Analogs

                          -
AVP   H-Cys-Tyr-Phe-Gln-Asn-Cys-Pro-^{L}Arg-Gly-NH$_2$

Arginine Vasopressin

                          -
LVP   H-Cys-Tyr-Phe-Gln-Asn-Cys-Pro-Lys-Gly-NH$_2$

Lysine Vasopressin

                          -
DDAVP   desamino-Cys-Tyr-Phe-Gln-Asn-Cys-Pro-^{L}Arg-Gly-NH$_2$

Desmopressin Acetate

                              -
DGLVP   H-Cys-Tyr-Phe-Gln-Asn-Cys-Pro-Lys-OH

Desglycinamide Lysine
    Vasopressin

                          -
DGAVP   H-Cys-Tyr-Phe-Gln-Asn-Cys-Pro-Arg-OH

Desglycinamide Arginine
    Vasopressin

TGLVP   N-alpha-glycyl-glycyl-glycyl-
                          -
                  Cys-Tyr-Phe-Gln-Asn-Cys-Pro-Lys-Gly-NH$_2$

---

nasal spray. The interval between administration of DGAVP and the tests of auditory and visual memory ranged from 51 to 111 minutes. There were no effects of treatment on the Visual Memory Test (VMT). Buschke's Selective Reminding Method was employed to assess the effects of vasopressin administration on auditory memory. Again, no effects of treatment were found.

The Tactile Memory Test has also been used to explore the effects of vasopressin on human memory (Posmurova, Alda, Plavka, Filip & Karen, 1983). Eighteen male and 18 female volunteers, ranging from 20-25 years of age, each participated in three experimental sessions; the minimum interval between two experimental sessions was 10 days. Each subject received a sequence of three single-dose treatments (8 ug of DDAVP, 100 ug of TGLVP and saline); one treatment was intramuscularly administered per experimental session. The sequence of administration was according to a predetermined Latin square design. The Tactile Memory Test was administered 95 minutes following each treatment. DDAVP significantly increased the mean score on the Tactile Memory Test. TGLVP had no influence on memory for this task. The authors also assessed the effects of vasopressin administration on performance of a Picture Recognition Test, a Story Reproduction Test and a Topographical Memory Test. Only the Story Reproduction Test yielded a significant treatment effect. TGLVP increased the number of logical units remembered during both immediate and delayed recall (3.5 hours following treatment). The

mean number of logical units remembered during immediate and delayed recall did not significantly differ following administration of TGLVP or saline; however, DDAVP decreased delayed recall when compared to immediate recall.

Several studies employed free recall of lists of words in an attempt to assess the effects of various vasopressin analogs on memory. Twenty male volunteers (mean age 24) participated in a study reported by Fehm-Wolfsdorf, Voigt & Fehm (1983). Twenty lists of 15 common German words were acoustically presented to the subjects (1 item/second) under instructions of "immediate free recall," followed by twenty additional lists under instructions of "delayed free recall." Following presentation of each of the latter 20 lists, a 30 second delay period ensued during which a shadowing-task was employed; subjects were instructed to repeat a random series of digits aloud upon presentation. The initial treatment occurred at the end of the first experimental session. Subjects intranasally instilled one puff of LVP (10 I.U.) or a placebo. Subjects were further instructed to self-administer a similar dose for three consecutive days. Three days following the first session, subjects were again confronted with the immediate and delayed free recall situations. In addition, subjects were unexpectedly asked to write down as many words from all the lists as they could recall (final free recall). Treatment with LVP prolonged the primacy effect, while treatment with the placebo enhanced the recency effect during

immediate recall. Results of the delayed and final free recall measures did not yield significant effects of treatment.

In a study of the effects of LVP and oxytocin (a neuropeptide similar to vasopressin in molecular structure) on memory, Fehm-Wolfsdorf, Born, Voigt and Fehm (1984) employed an immediate and a final free recall. Following pretraining, thirty young, male volunteers (mean age 24) were acoustically presented with ten lists of common German monosyllabic words at a rate of 1 item/2 seconds. Following the first session, subjects were treated with two puffs of intranasal spray, which contained 10 I.U. LVP, OXT or placebo. Subjects received a similar treatment 24 hours prior and one hour prior to the second session. The second session was scheduled one week after the initial session. During the second session, subjects were exposed to the original ten lists of words, as well as ten new lists of words. Following both sessions, subjects were asked to recall as many words as possible. Following the second session, subjects were unexpectedly asked to recall words from all previous lists. Treatment with LVP did not influence the number of words remembered correctly on both the immediate and final free recall tasks; whereas treatment with OXT impaired recall.

Pietrowsky, Fehm-Wolfsdorf, Born and Fehm (1988) instructed 13 healthy male volunteers (mean age 24.3) to intranasally self-administer either 1 mg DGAVP or placebo. Administration occurred 48, 24 and 1 hour prior to the subject's appearing at the laboratory, however the memory test did not occur until 3 hours following the

most recent treatment. Each subject participated in two experimental sessions resulting in a within-subject cross-over design. The order of treatments was counterbalanced across subjects. All experimental sessions were at least one week apart. The authors employed the same list of words they used previously (i.e. Fehm-Wolfsdorf, et al., 1983; Fehm-Wolfsdorf, et al. 1984). Items were again presented at a rate of 1 item/2 seconds. Following presentation of the words, subjects were asked to list as many words as they could remember irrespective of order (free-recall paradigm). Treatment with DGAVP significantly enhanced the recency effect and attenuated the primacy effect; however total number of words recalled was unaffected.

Weingartner, Gold, Ballenger, Smallberg, Summers, Rubinow, Post and Goodwin (1981) conducted a number of experiments in which they assessed the effect of DDAVP on memory in healthy young adults, as well as mood disordered individuals. In an experiment employing unimpaired subjects (4 males, 2 females), 30-60 ug of DDAVP was intranasally administered 3 times per day for 2-3 weeks. Relative to baseline measures, DDAVP enhanced serial learning, prompted free recall and recall of semantically related words. DDAVP did not affect consistency of recall. A similar group of subjects treated with the vehicle solution for 8 weeks did not demonstrate any changes on the memory tasks.

Weingartner et al. (1981) also treated four mood-disordered female patients with DDAVP. Results are discussed relative to

baseline measurements. The patients showed enhanced prompted free recall, recall of semantically related words, consistency of previously remembered words and organization of remembered words beginning 2 days after treatment onset and continuing for 2 weeks. Treatment with DDAVP did not affect performance of a serial learning task. In an additional study, DDAVP was found to partially reverse the retrograde amnesia that follows electroconvulsive treatment.

Millar, Jeffcoate and Walder (1987) assessed the effects of 40 ug of DDAVP on a short-term memory task, a semantic recognition task and a simple unprepared visual reaction time. In the same study the authors also explored the effects of DDAVP on alcohol-induced amnesia. Thirty-six male medical students were randomly divided into four groups (DDAVP plus alcohol, DDAVP plus placebo-alcohol, placebo-vasopressin plus alcohol and placebo-vasopressin plus placebo-alcohol). DDAVP was administered intranasally, and alcohol was administered as vodka at 2 ml per kilo body weight in an equal volume of fresh orange juice. After a 40 minute absorption period, subjects listened to 15 12-word lists presented at a rate of one word per 2 seconds. During a 20 second inter-list interval, subjects were instructed to recall as many words as possible from the previous list. Following completion of the short-term memory task, a semantic recognition task was implemented in which a category name and a test word were simultaneously presented on a VDU. Speed and accuracy of vocal binary decisions regarding

category membership of the test word were recorded. One hundred and twenty trials were completed. Thirdly, subjects completed 30 trials of a simple, unprepared visual reaction time task. Results indicated that DDAVP improved short-term memory performance of the placebo-alcohol and the alcohol groups when compared to placebo-vasopressin. DDAVP had no effect on the decision latencies associated with semantic recognition, and no effect on simple reaction time.

The subjects were asked to return to the laboratory approximately 24 hours later (K. Millar, personal communication, March 25, 1988). At this time subjects were asked to recall as many words as possible from the baseline and experimental sessions of the short-term memory trials. Subjects were then presented with the 30 category names employed in the semantic recognition task, and asked to recall as many test words as possible from both the baseline and experimental trials. Although treatment did not affect baseline recall, DDAVP impaired recall of experimental words from both the short-term memory tasks and the semantic recognition trials. The results suggest that while DDAVP enhanced short-term memory recall, the peptide impaired long-term memory recall. The authors discuss the results in terms of state dependent learning suggesting that DDAVP may produce a state of cognitive arousal.

In an attempt to better represent typical verbal learning processes of everyday situations, three published studies have

assessed the effects of acute administration of DDAVP on sentence memory. Beckwith, Till and Schneider (1984) treated 64 male and 64 female subjects (age 18-33) with 60 ug (i.n.) DDAVP or saline. Approximately 20 minutes following the treatment 16 implicational sentences were presented by ear phone from a cassette tape. The authors manipulated both encoding strategies (comprehension or memorization instructions) and retrieval procedures (free-recall or cued-recall paradigm). DDAVP enhanced recall across encoding and retrieval conditions in male subjects, but had no effect on the performance of female subjects.

A further study assessing the effects of DDAVP on sentence memory employed a cross-over design in which one group of subjects received 60 ug DDAVP during a first session and placebo during a second session, which occurred approximately seven days later (Till & Beckwith, 1985). A second group received similar treatment in reverse order, while a third group received placebo during both experimental sessions. Each group consisted of 14 healthy males ranging from 18 to 33 years of age. Following treatment, subjects were required to remain in a supine position for 20 minutes. During the initial session a 16-sentence list was presented acoustically at a rate of one new sentence every 20 seconds. Following a 1 minute distractor task, subjects were given 5 minutes to complete a free recall. The same procedure was followed during the second session; however, subjects were further instructed to complete a cued recall for the second session

sentences, as well as a delayed recall test for the previous session's sentence list. Results indicated that DDAVP improved immediate recall during Session 1, but not during Session 2. DDAVP was also found to facilitate delayed recall for the Placebo-DDAVP group. The authors suggested that this finding may indicate a retrieval locus for the DDAVP effect. Post hoc analyses of these data further suggest that individual differences (e.g. verbal ability) are important in understanding the effects of vasopressin on memory. DDAVP improved immediate recall more for low-verbal subjects and delayed recall more for high-verbal subjects.

Beckwith, Till, Reno and Poland (1990) studied the dose-response relationship of DDAVP to sentence memory in healthy young adults (age 18-37). Seventy males were divided into five groups receiving either 60, 30, 15, 5 or 0 ug of DDAVP. Twenty minutes following treatment administration, a list of 16 sentences were acoustically presented to the subjects at a rate of one new sentence every 20 seconds. After a one minute distractor task, subjects were allowed 5 minutes during which to complete a free recall of the sentences. Subjects were subsequently presented with a list of 16 cue words, and given an additional 5 minutes to complete a cued-recall. Treatment with 60 ug of DDAVP enhanced cued-recall compared to those receiving 5 or 15 ug of DDAVP, but had no effect on free recall. Relative to the placebo group, 15 ug of DDAVP impaired recall for both free- and cued-recall.

Beckwith, Petros, Bergloff and Staebler (1987) allowed for further generalizability to more naturalistic types of learning by assessing the effects of DDAVP on recall of narrative prose. Forty healthy males (age 18-25) received intranasal treatment with either 60 ug DDAVP or saline. Twenty minutes following administration, six 200-220 word narrative passages were presented at slow, medium and fast rates. DDAVP was found to facilitate recall of idea units within the passages of both high and medium levels of importance. DDAVP had no influence on recall of idea units at the low level of importance. The authors interpreted these results as evidence that DDAVP "may have facilitated the divided attentional processes necessary to integrate text in working memory as evidenced by the increased attention to relevant as opposed to irrelevant details of the passages presented" (p.431).

To date, only two studies have explored possible differential treatment effects on the cognitive performance of male and female subjects. Beckwith et al. (1984) first addressed the gender question. As previously mentioned, the authors reported enhanced sentence recall for males treated with DDAVP, but no treatment effect on the performance of female subjects. In view of this sexually dimorphic effect and previous literature suggesting differential gender-related abilities, Beckwith, Petros and Knutson (1990) designed a study to look specifically at the effect of DDAVP on performance of both verbal and visuospatial memory tasks in male and female subjects. The authors intranasally instilled either

60 ug of DDAVP or saline to 40 male and 40 female subjects (age 18-30). Approximately 20 minutes following administration, subjects participated in Immediate and Final Free Recall of Lists of Words, the Paper Folding Test and the Stoop Color Word Test. The order of task presentation was counterbalanced across subjects. The Immediate Free Recall task employed one practice and twelve test lists of words.

Although no significant main effects for treatment or gender were found, significant three-way interactions suggest that DDAVP impaired recall at specific levels of practice, rates of presentation and in respect to certain serial positions. Final Free Recall of Lists of Words and the Paper Folding Test yielded no main effects or significant interactions involving treatment. No main effects or interactions involving treatment or gender were found for the word and interference subtests of the Stoop Color Word Test; however, main effects for treatment and gender, as well as a gender by treatment interaction were apparent upon analysis of the color naming subtest. DDAVP decreased the mean number of colors named. The treatment effect was sexually dimorphic in that DDAVP did not effect the performance of males, but impaired the performance of females.

Several other studies have focused on the role of vasopressin in selective attention. In a study previously discussed, Beckwith et al. (1982) used a visual discrimination task to assess the effects of vasopressin on the learning of a concept shift problem.

Approximately 20 minutes following administration of DDAVP, subjects completed a series of visual discriminations. DDAVP significantly enhanced learning of all the concept shift problems including: original learning, reversal learning, intradimensional shift and extradimensional shift. The authors suggested that DDAVP enhanced selective attention. In addition, Snel et al. (1987) reported that male subjects treated with DGAVP had significantly fewer corrected errors on the Bourdon Concentration Test and Beckwith et al. (1987) reported facilitation of working memory, again suggesting enhanced attention after treatment.

The Sternberg Item Recognition Task, in which the subject is asked to decide whether a visually presented digit was a member of a previously memorized set of digits, has also been employed to test the effects of vasopressin administration on information processing. Beckwith, Couk and Till (1983) administered either 60 ug DDAVP in 0.6 ml solution or the same volume of saline to 15 healthy male volunteers (18-24 years of age) according to a cross-over design with a 7 day interval between the two sessions. Treatment was administered intranasally and preceded the first block of test trials by 25 minutes. DDAVP increased alertness, rate of digit encoding and rate of response selection when administered during the second treatment session. The authors interpret these findings as demonstrating improved attentional processing. DDAVP did not influence the linear function relating reaction time to memory set

size, and is therefore not believed to have had a direct effect on memory.

Nebes, Reynolds and Horn (1984) also employed the Sternberg paradigm to assess the effects of DDAVP on short-term memory processes. In the same study, the authors employed tasks to test the neuropeptide's effect on episodic and semantic long-term memory, as well as a simple vocal reaction time. Both young and elderly males were employed in the study in an attempt to assess possible age-related treatment differences. In a cross-over design, twenty-four healthy young males (age 20 -30) and twenty-four healthy elderly males (age 60-70) received either DDAVP (10 ug on Day 1, 20 ug on Day 2, 30 ug on Days 3-8) or placebo intranasally for 2 8-day periods; a 1 month washout period separated the treatment periods.

The memory tasks were presented in a counter-balanced order at both the beginning and the end of each treatment period. During each experimental session, subjects completed 3 series (2 digits, 3 digits and 4 digits) of 48 trials of the Sternberg task. In an attempt to assess DDAVP's effects on episodic memory, subjects were asked to memorize a pair of items consisting of two letters (bigram) and a one-syllable word beginning with the same two letters. Following memorization, subjects were first asked to vocally identify the bigrams, and subsequently directed to recall the associated item. For the semantic memory task, subjects were given 12 semantic categories and asked to name a member of that category beginning

with a specified letter. Thirty trials of the simple vocal reaction time trials were presented at the beginning and end of each session.

Results of the Sternberg task suggest that DDAVP enhanced both retrieval (memory comparison time) and non-retrieval (perceptual-motor) stages of short-term memory. Although no treatment effect was found for identification, results of the task employing episodic long-term memory suggest that DDAVP facilitated retrieval of associated items. DDAVP did not affect semantic memory access, nor simple vocal reaction time. There was no indication of a differential effect on the two age groups.

Statement of Problem

The results of several of the studies reviewed assessing the effects of vasopressin analogs (DDAVP, LVP, TGAVP, DGAVP) on various memory paradigms suggest a consistently modest effect of vasopressin on human memory. It is difficult to account for the few negative findings given the methodologic variance across studies (See Table 2). What is impressive is the large number of positive findings despite considerable variation in techniques.

In addition to possible differential effects due to pharmacological variables, there is evidence that the effect of vasopressin on human memory may vary as a function of individual differences (e.g. gender, verbal ability). Beckwith et al. (1984; 1990) reported a sexually dimorphic effect. DDAVP was shown to enhance sentence recall for male subjects only (Beckwith et al., 1984), and to impair color naming for female subjects only

Table 2

Methodological Variables Employed in Studies of the Effects of
Vasopressin on Memory in Healthy Young Volunteers

Analog Administered

Route of Administration

Dose of Peptide

Frequency of Administration

Interval Between Administration and Testing

Time of Day (Administration, Testing)

Gender of Subjects

Method of Testing Memory

(Beckwith et al., 1990). In regard to verbal ability, Till & Beckwith
(1985) found that treatment with DDAVP improved immediate
sentence memory more for low-verbal subjects, whereas the
treatment effect for delayed memory was greater for high-verbal
subjects. Although the relationship between individual differences
and treatment effects are not entirely clear, these findings suggest
that variables such as gender and verbal ability may modulate the
effect of vasopressin on human memory.

The mechanism by which vasopressin affects cognitive
performance remains to be elucidated. In order to specify the
cognitive processes modified by the neuropeptide, further research
must be guided by theoretical models of human memory. There are
currently two prevailing models: multistore and levels of

processing models. The multistore model predominated throughout the 1960's (Ashcraft, 1989); however, in the late 1960's and early 1970's theorists became dissatisfied with the multistore model of memory (Craik & Lockhart, 1972). These same theorists argued that depth or levels of processing provides a much more comprehensive conceptual framework from which research questions may be generated.

The multistore models propose three levels of storage: sensory stores, short-term memory (STM) and long-term memory (LTM) (Atkinson & Schiffrin, 1968). Input to the sensory stores is preattentive and a literal representative of the stimuli. However, it is not possible to maintain information in the sensory stores, since it is overwritten by further inputs of the same modality. Thus, while capacity of the sensory stores is large, trace duration is transient (1/4-2 seconds). The limited capacity of STM (approximately 7 units of information) and the somewhat extended rate of forgetting (5-20 seconds) differentiates STM from the sensory stores. Entry and maintenance of information within the STM require attention and rehearsal, respectively. Verbal input is believed to be coded in a phonemic fashion, and information loss probably occurs through displacement or decay. There is no known limit for LTM capacity or for trace duration. Information loss is likely due to loss of accessibility. Rehearsal facilitates entry of information into LTM (a large and enduring memory system), and maintenance of information occurs through repetition and

organization. Information is largely semantically coded; however, some auditory and visual information may be stored within LTM.

In view of empirical data regarding capacity, coding and forgetting characteristics, many theorists have favored the levels of processing theory over the multistore models. These theorists have argued that perception involves a rapid analysis of stimuli at a number of levels or stages, and that memory trace is a result of this perceptual analysis (Craik & Lockhart, 1972). According to levels of processing theory, preliminary stages of processing encompass analysis of physical or sensory features such as lines, angles, brightness, pitch and loudness, while deeper stages are more concerned with pattern recognition and extraction of meaning. Thus, greater "depth of processing" implies a greater degree of semantic or cognitive analysis. Deeper levels of analysis are associated with more elaborate, longer lasting, and stronger memory traces.

Although it may be "possible to draw a box around the early analyses and call it sensory memory and a box around intermediate analyses called short-term memory," theorists argue that this "procedure both oversimplifies matters and evades the more significant issues" (Craik & Lockhart, 1972, p. 675). For example, some theorists argue that STM is but a small component of a more elaborate working memory (Ashcraft, 1989). While "short-term memory" typically refers to the input and storage of new information, the term "working memory" is used to depict "the mental workplace for retrieval and use of already known

information" (Ashcraft, 1989, p. 140). Thus, working memory is responsible for the retrieval of word meanings and the further integration of this information, which results in the understanding of a sentence.

Since integration of information in working memory is an important factor underlying a subject's ability to remember prose material and since vasopressin has been shown to improve recall of prose (Beckwith et al., 1987; Posmurova et al., 1983), further research is needed to explore the mechanisms through which vasopressin may increase the efficiency of working memory. One component of prose processing known to influence the efficiency of working memory is speed of accessing information from LTM (Haut, Beckwith, Petros & Russell, 1989). In the present study, the Category Judgement task was employed to obtain measures of accessing long-term memory.

Specifically, the current study compared the performance of vasopressin-treated subjects with control subjects on the speed and accuracy of encoding physical features of a word (word encoding), accessing the name of the word (lexical access), and accessing categorical information about a word (semantic memory access). Subjects were required to make three different types of decisions involving a pair of words (physically identical, same name, same category). The word pairs were chosen from Rosch's (1975) semantic category list. Rosch has previously shown that accessing categorical information requires more processing time than

accessing information about the name of a word, or encoding the letters or physical features of a word. Thus, if vasopressin affects access speed, the effect should increase as the decisions necessitate more processing time (i.e., categorical information).

Secondly, as indicated above, individual differences may influence the nature of the effect found after treatment with vasopressin; therefore the present study was designed to examine possible gender differences in the effects of vasopressin on the speed of accessing long-term memory. Gender differences are quite probable in view of animal studies which report a sexually dimorphic effect of AVP on retention of a passive-avoidance response (Tinius et al., 1987; Swenson et al., 1990) and human studies reporting a sexually dimorphic effect on human cognition (Beckwith et al., 1985; 1990). The sexually dimorphic effect of this neuropeptide may well be the result of differential distribution of vasopressinergic neurons in the developing brain. Swaab and Boer (1983) point out that at day 12 of life male rats have a denser vasopressinergic innervation of the lateral septum and lateral habenula than female rats. In addition, Buijs (1987) has noted a differential distribution of vasopressin in the CNS of adult male and female rats. Therefore, the present study assessed performance of both male and female subjects on the category judgement task.

CHAPTER II

METHOD

Subjects

Forty-one female and forty-three male undergraduate college students ranging from 18 to 34 years of age participated in the current study. A self-report questionnaire was employed to screen subjects for health-related problems. Individuals with a history of cardiovascular problems and/or hypertension, as well as females using oral contraceptives, were excluded from participation in the study. Each female subject was tested during the first five days of her menstrual cycle to minimize the possibility of pregnancy and to insure that endogenous hormonal effects remained relatively constant among female subjects. During the 48 hour period prior to participation in the study, all subjects were free of alcohol and caffeine, as well as over-the-counter and prescription medications. The procedures used in the study were reviewed and approved by the University Institutional Review Board and subjects were informed of their right to withdraw from participation at any time during the study.

Materials

Screening Questionnaire. A screening questionnaire (See Appendix A) was constructed to elicit self-report of variables which

might confound treatment effects. Subjects were asked to report the frequency and amount of all drug usage. Subjects were asked specifically about their use of caffeine, alcohol and nicotine. In addition, the subjects were asked to describe their general health in the last year, as well as specific medical conditions (i.e. high blood pressure, allergies, ulcers, cardiovascular disease and epilepsy). If the individual subject acknowledged the use of prescription or over-the-counter medication, he/she was asked to describe the reason for taking the medication and the duration of usage. Females were further questioned regarding pregnancy and the use of oral contraceptives. Lastly, subjects were asked if they would be willing to participate in a study of the effects of vasopressin on memory.

Blood Pressure. A Marshall 85 oscillometric sphygmomanometer (manufactured by Omron Marshall Products, Inc., Lincolnshire, Illinois) was used to obtain measures of systolic and diastolic blood pressure. The electronic device presented digital information, which was observed and manually recorded.

Vocabulary Test. The vocabulary subtest from the Wechsler Adult Intelligence Scale - Revised (WAIS-R; Wechsler, 1981) was used to obtain an objective assessment of each subject's word knowledge. The WAIS-R vocabulary test consists of 35 words, which are verbally administered in an order of increasing difficulty. Responses were scored zero, one or two points according to the scoring criteria found in Appendix A of the WAIS-R manual. Raw

scores on the WAIS-R vocabulary subtest range from 0 to 70. The vocabulary test together with Information and Block Design are the most reliable of the WAIS-R subtests across all age groups, and have the smallest standard error measurements. For individuals from 18-35 years of age, reliability on the vocabulary subtest ranges from .94-.96, and the standard error of measurement ranges from .52-.67.

Treatment. Desmopressin acetate (DDAVP), a synthetic analog of 8-arginine vasopressin, is manufactured by Rorer Pharmaceutical Corporation, Fort Washington, Pennsylvania. The primary structure of the analogue is as follows: $C_{48}H_{74}N_{14}O_{17}S_2$ [SCH$_2$CH$_2$CO-Tyr-Phe-Gln-Asn-Cys] -Pro-D-Arg-Gly-NH$_2$.C$_2$H$_4$O$_2$.3H$_2$O. The active structure is 1(3-mercaptopropionic acid)-8-D-arginine vasopressin. The intranasal preparation of DDAVP is a sterile, aqueous solution. Each ml of solution contains 0.1 mg Desmopressin acetate, 5.0 mg Chlorobutanol, 9.0 mg Sodium chloride and Hydrochloric acid to adjust pH to approximately 4. The intranasal preparation of DDAVP has antidiuretic activity of about 400 IU (Physician's Desk Reference, 1989). Compared to arginine vasopressin, DDAVP has reduced vasopressor and antidiuretic effects.

Category Judgement. In the present study, the Category Judgement task was employed. In this particular task the subject is confronted with a word pair, and asked to make a decision regarding the similarity or the disparity of the two words. The word pairs were chosen from Rosch's (1975) semantic category list and are all highly typical, possessing a rank of 30 or less on Rosch's normative

scale (See Appendix B for word lists). The Category Judgement task employs three types of decisions: physically identical (PI), for example, DOG/DOG; same name (SN), for example, DOG/dog; and same category (SC), for example, DOG/cat. The categories employed were furniture, vehicles, birds, clothes, tools, sports, weapons and fruits. The eight categories occurred equally often for each decision type. The subjects were required to judge the two words as "the same" or "different." Upper and lower cases appeared equally often for both positive and negative decisions. The word pairs were presented by an Apple IIe computer and were displayed on a monochrome screen. The words were presented in sequences of 96 word pairs such that 32 word pairs were used for Physical Identity (PI) decisions, 32 word pairs were used for Same Name (SN) decisions and 32 word pairs were used for Same Category (SC) decisions. One half of the decisions were positive and one half were negative; thus, sequences containing 96 trials were composed of 16 trials per condition.

Reaction Time Control. The reaction time control task was employed in the current study to assess the time required to complete the motor task of pressing a computer key. The task begins with the appearance of the word "right" or "left" on the computer screen. The words instructed the subject with which index finger to respond. The stimulus word was presented on the computer screen and remained for three seconds. Since memory access was assumed complete following this delay, the subsequent response time was considered an index of the time needed to execute

the motor component of the response. This measure aided in distinguishing the effect on memory produced by exposure to DDAVP from possible effects on the time required for the motor response.

Procedure

Subjects, who reported an absence of chronic and acute illnesses and who denied use of medication, alcohol and other drugs during the 48 hours prior to experimentation, were briefed regarding the nature of the hormone to be administered, possible side-effects and the tasks involved in participation. Subjects were further screened for high blood pressure. At the beginning of the experiment, all subjects had blood pressures less than 140/90 mm of Hg. Upon completion of the screening procedures, subjects were asked to sign an informed consent form (Appendix C), and notified of their right to withdraw from the study at any time. After informed consent was obtained, the vocabulary test was administered. To insure that both groups were equivalent in terms of their verbal ability, subjects were assigned to either the DDAVP or placebo treatment condition based on the subject's raw vocabulary in a manner ensuring similar verbal ability between groups.

Instillation of Hormone and Placebo. Following group assignment, the subjects were instructed to recline in a supine position with the head tilted backwards. While the subject reclined, an intranasal preparation of 60 ug DDAVP in 0.6 ml of solution or 0.6 ml of saline was slowly instilled over approximately a 15 second interval. The solution was instilled into one nostril (usually the

right). To insure absorption by the intranasal mucous membranes, subjects were instructed to remain in the supine position for 20 minutes following administration.

Testing. Following the absorption period, all subjects received a sequence of practice trials (twelve trials per condition) followed by 16 experimental trials per condition (96 experimental trials total). Response time, the time between stimulus onset and motor response, and the accuracy of the response were recorded and stored for analysis. Upon completion of the experimental trials, the subjects completed a sequence of 32 reaction time control trials.

Unexpected Free Recall. After completing the reaction time control trials, subjects were asked to recall as many of the words as possible. It is important to note that the subjects were not previously briefed regarding the free recall; thus, the data obtained from the unexpected free recall served as an index for incidental learning. Upon completion of the free recall task, the subjects were debriefed and allowed to depart. All testing was completed between 1400 and 2000 hours.

CHAPTER III

RESULTS

All data analyses were conducted with alpha set at .05. The
Newman-Keuls procedure was used for further analysis of main
effects and interactions.

Individual Differences

Age of the subjects, raw score on the WAIS-R vocabulary
subtest, systolic and diastolic blood pressure and self-reported
weight were analyzed by means of a 2 (group) by 2 (gender) between
groups analysis of variance (ANOVA) to determine if the groups
(DDAVP females, DDAVP males, placebo females, placebo males)
differed on any of these individual variables prior to treatment. A
one-way between groups ANOVA was conducted on the day of the
menstrual cycle on which the female subjects participated. The
ANOVA tables are presented in Appendix D (See Tables 11-16).

The analysis on age of the subjects revealed no main effects of
group, $F(1,80)<1$, $p>.50$, or gender, $F(1,80)=2.57$, $p=.11$. The group by
gender interaction was not significant, $F(1,80)=1.55$, $p=.22$. For the
WAIS-R vocabulary subtest raw score, there were no main effects of
group, $F(1,79)<1$, $p>.50$, or gender, $F(1,79)=1.64$, $p=.21$. The group by
gender interaction, $F(1,79)<1$, $p>.50$, was not significant. One male's
data (DDAVP group) was excluded from the analysis, because of

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familiarity with the subtest. The means and standard deviations are presented in Table 3.

Table 3

Mean Age and Mean WAIS-R Vocabulary Subtest Raw Score for Female and Male Subjects at Each Level of Treatment

	Age		WAIS-R vocabulary subtest raw score	
	Female	Male	Female	Male
DDAVP				
M	19.10	21.00	47.50	49.76
SD	1.80	3.38	6.95	6.99
Placebo				
M	20.14	20.38	46.29	48.62
SD	3.99	2.52	9.21	9.17

For diastolic blood pressure, there were no main effects of group, $F(1,79)<1$, $p=.48$, or gender, $F(1,79)=2.20$, $p=.14$. The group by gender interaction was not significant, $F(1,79)<1$, $p>.50$. For the systolic blood pressure, the results revealed a main effect of gender ($F(1,79)=32.13$, $p<.001$) in that male subjects had higher systolic blood pressure than female subjects. The main effect of group, $F(1,79)<1$, $p>.50$, and the group by gender interaction, $F(1,79)<1$, $p>.50$, were not significant. Analysis of covariance adjusting for systolic blood pressure did not affect the results of the analyses of

variance on the dependent variables for subsequent analyses. The means and standard deviations are presented in Table 4.

Table 4

Mean Diastolic and Mean Systolic Blood Pressure for Female and Male Subjects at Each Level of Treatment

| | Diastolic Blood Pressure | | Systolic Blood Pressure | |
	Female	Male	Female	Male
DDAVP				
M	66.80	68.95	110.15	121.62
SD	8.59	5.44	10.04	9.48
Placebo				
M	65.24	68.14	111.00	123.10
SD	10.28	5.76	9.45	8.90

Males in this study's sample weighed significantly more than females, $F(1,78)=55.23$, $p<.001$. The analysis on weight revealed neither significant effects for group, $F(1,78)<1$, $p>.5$, nor a group by gender interaction, $F(1,78)=1.24$, $p=.27$. Analysis of covariance adjusting for weight did not affect the results of the analyses of variance on the dependent variables for subsequent analyses. The day of the menstrual cycle on which female subjects participated in the study was not significantly different between groups, $F(1,39)=1.14$, $p=.30$. The means and standard deviations are presented in Table 5.

Table 5

Mean Self-reported Weight for Female and Male Subjects and Mean

Day of Menstrual Cycle for Females at Each Level of Treatment

| | Weight | | Day of Menstrual Cycle |
	Female	Male	Female
DDAVP			
M	138.00	168.50	3.90
SD	20.30	24.30	1.37
Placebo			
M	134.05	175.30	3.48
SD	17.89	23.99	1.17

Response Times

The median response time was obtained for every subject in

each cell of the design. Response times associated with errors were

excluded. The F max test with alpha set at .05 revealed

heterogeneity of variance for the raw data. A logarithmic

transformation (log10) was performed on the data to reduce

heterogeneity of the variance. The transformed data were analyzed

by means of a 2 (treatment) x 2 (gender) x 3 (decision type) x 2

(response type) mixed analysis of variance with repeated measures

on the last two factors. The ANOVA table is presented in Appendix D

(See Table 17).

The analysis of median response times on the experimental trials yielded no significant main effects of treatment, $F(1,80)<1$, $p>.50$, or gender, $F(1,80)<1$, $p>.50$. Main effects were found for decision type, $F(2,160)=870.80$, $p<.001$, and for response type, $F(1,80)=75.97$, $p<.001$. Subjects required significantly more time to respond to semantic (same category) decisions than to lexical (same name) decisions, which required significantly more time to respond than decisions based on physical features (physically identical). Subjects responded more quickly to positive decisions than to negative decisions.

A significant interaction of decision type by response type was observed, $F(2,160)=17.24$, $p<.001$. Subsequent Newman-Keuls testing revealed that subjects responded significantly slower on negative decision trials than positive trials for all decisions; however, the size of the difference between positive and negative response times (same/different effect) varied as a function of decision type. For example, same/different effects were 2.69%, 4.64% and 11.58% for PI, SN and SC decisions, respectively (Percent differences were calculated by dividing the absolute difference by the larger number). No other 2 or 3 way interactions were significant. Means and standard deviations are presented in Table 6.

Response Time Control

Median response time for response time controls were obtained for each subject. The F max statistic was used to test for homogeneity of the variance with alpha set at .05. Because the

Table 6

Median Response Time on Positive and Negative Experimental Trials

for Subjects at Each Level of Treatment and Decision Type

	Positive			Negative		
	PI	SN	SC	PI	SN	SC
DDAVP						
M	640.12	658.83	1094.19	635.15	694.21	1239.67
SD	126.15	78.04	196.20	98.14	85.10	212.98
Placebo						
M	638.54	680.48	1070.46	679.48	710.24	1208.01
SD	179.89	213.21	351.46	249.55	183.26	308.87

assumption of homogeneity was violated, the data were transformed using a logarithmic transformation (log10). A 2 (treatment) x 2 (gender) x 2 (response handedness) mixed analysis of variance was conducted on the transformed data. The ANOVA table is presented in Appendix D (See Table 18).

Analysis of the transformed response time control data revealed no significant main effects of treatment, $F(1,80)=2.41$, $p=.13$, or gender, $F(1,80)=2.80$, $p=.10$. A main effect of response handedness, $F(1,80)=9.86$, $p=.003$, was found, as was a significant treatment by response handedness interaction, $F(1,80)=6.73$, $p=0.01$ (See Figure 1). Subjects treated with DDAVP responded significantly slower with both hands, and slower with the right hand compared to
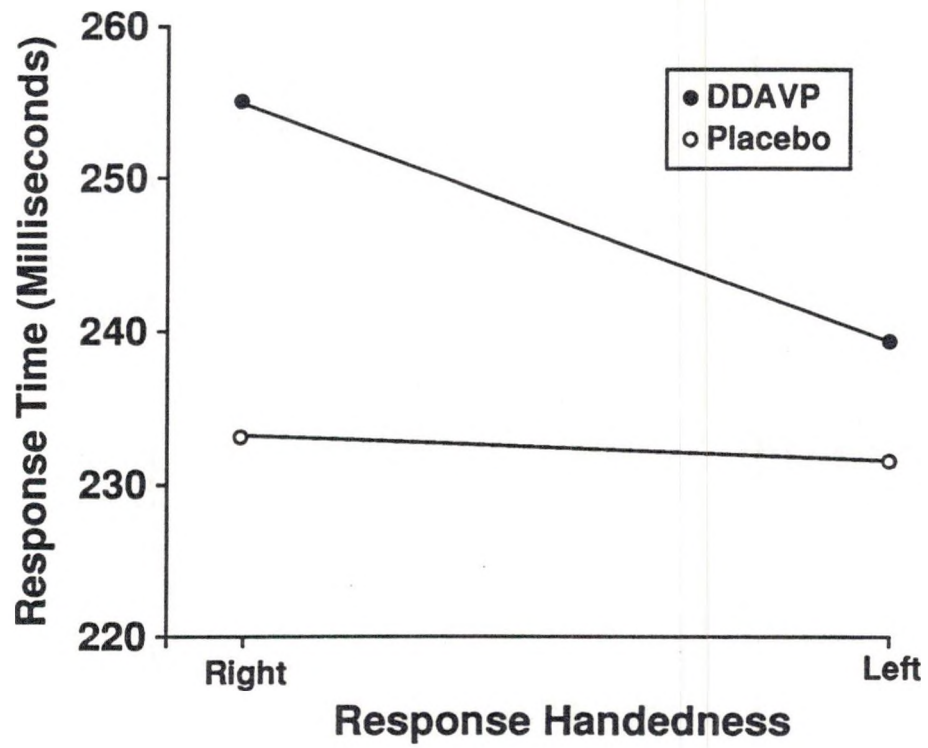
Figure 1. Median response time controls as a function
of treatment and response handedness.

left handed responses. Subjects treated with the placebo did not differ in regard to response handedness. No other 2 or 3 way interactions were significant. Means and standard deviations are presented in Table 7.

Table 7

Median Response Time Controls for Subjects at Each Level of Treatment and Response Handedness

	Right	Left
DDAVP		
M	253.96	239.19
SD	58.95	44.86
Placebo		
M	232.52	230.86
SD	30.15	24.53

Difference Scores

A 2 (treatment) x 2 (gender) x 3 (decision type) x 2 (response type) mixed analysis of variance was performed on data generated by subtracting RTC trials from the overall response times (median experimental data minus median response time control data from the corresponding cell of the design). Since the assumption of homogeneity of the variance was violated for both the overall response time data and the response time control data, a logarithmic (log10) transformation was performed on the difference scores prior

to the ANOVA. The ANOVA table is presented in Appendix D (See Table 19).

The pattern of the main effects found in this analysis was similar to that found in the analysis of response times. Results of the analysis indicated significant main effects for decision, $F(2,160)=821.52$, $p<.001$, and response, $F(1,80)=73.91$, $p<.001$. Subjects required significantly more time to respond to semantic (same category) decisions than to lexical (same name) decisions, which required significantly more time to respond than decisions based on physical features (physically identical). Subjects responded more quickly to positive decisions than to negative decisions. Main effects of treatment, $F(1,80)<.001$, $p>.50$, and gender, $F(1,80)=1.26$, $p=.27$ were not significant.

The treatment by decision interaction, which was not significant in the analysis of response times, was found to be significant in the analysis of difference scores, $F(2,160)=3.20$, $p=.04$ (See Figure 2). Subjects treated with DDAVP responded more quickly to physically identical decisions than subjects receiving placebo. The treatment effect was not apparent for the other two types of decisions. Similar to results of the analysis conducted on the response times, the decision by response interaction was found to be significant, $F(2,160)=8.76$, $p<.001$. Subjects responded significantly slower on negative decision trials than positive trials at all levels of decision; however, the size of the same/different effect varied as
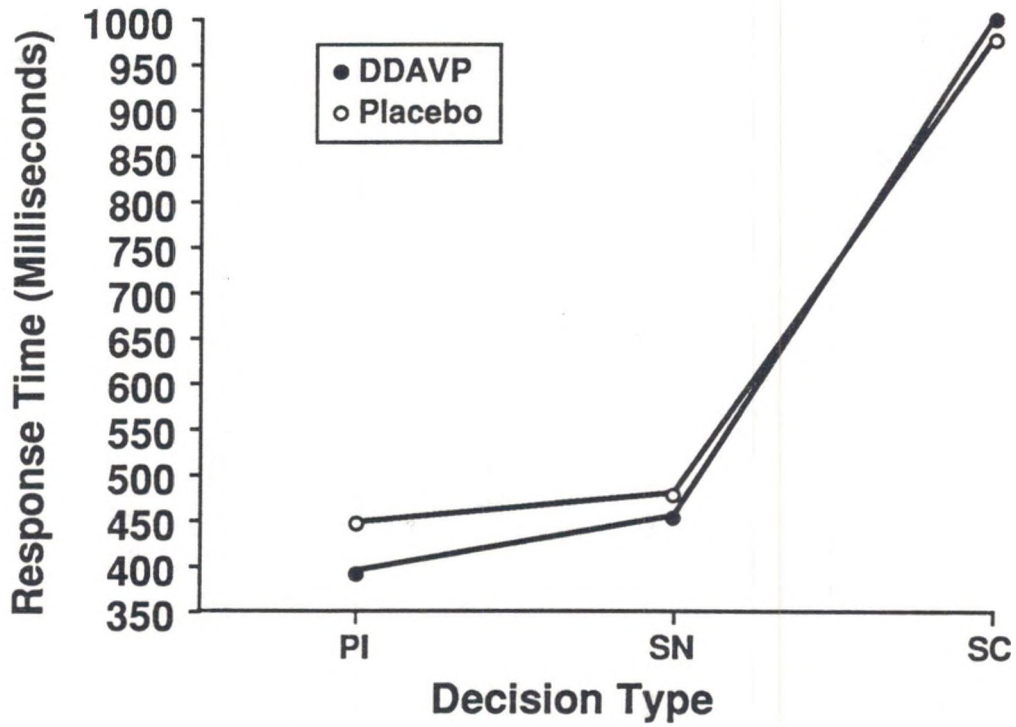
Figure 2. Median difference scores as a function
of treatment and decision type.

a function of decision type. For example, same/different effects were 1%, 1.69% and 2.58% for PI, SN and SC decisions, respectively.

Error Rates

Proportion of errors made during the experimental trials were computed for every subject at each cell of the design. The F max test with alpha set at .05 indicated heterogeneity of the variance; thus the proportions were transformed using the Arc sine transformation. A 2 (treatment) x 2 (gender) x 3 (decision type) x 2 (response type) analysis of variance was conducted on the transformed proportion of errors. The ANOVA table is presented in Appendix D (See Table 20). Means and standard deviations are presented in Tables 8 and 9.

The analysis revealed a significant main effect for decision $(F(2,160)=68.58, p<.001)$ in that subjects made a higher proportion of errors on same category decisions than on same name or physically identical decisions. Proportion of errors was also higher for same name decisions compared to proportion of errors on physically identical decisions. Main effects of treatment, $F(1,80)<1$, $p>.50$, gender, $F(1,80)<1$, $p>.50$, and response, $F(1,80)<1$, $p>.50$, were not significant.

A significant treatment x gender interaction was found, $F(1,80)=5.63$, $p=.02$ (See Figure 3). Newman-Keuls conducted on the differences between the simple effects means did not reveal any significant pairwise comparisons; however, the observed differences (.049 for females and .046 for males) approached

Table 8

Proportion Errors from Positive Experimental Trials for Female and
Male Subjects at Each Level of Treatment and Decision Type

	Female			Male		
	PI	SN	SC	PI	SN	SC
DDAVP						
M	0.022	0.047	0.116	0.051	0.071	0.145
SD	0.047	0.053	0.080	0.046	0.065	0.103
Placebo						
M	0.024	0.045	0.167	0.018	0.048	0.086
SD	0.046	0.053	0.122	0.029	0.056	0.078

Table 9

Proportion Errors from Negative Experimental Trials for Female and
Male Subjects at Each Level of Treatment and Decision Type

	Female			Male		
	PI	SN	SC	PI	SN	SC
DDAVP						
M	0.038	0.028	0.100	0.063	0.060	0.085
SD	0.068	0.038	0.077	0.070	0.065	0.097
Placebo						
M	0.045	0.065	0.158	0.054	0.036	0.110
SD	0.056	0.070	0.098	0.060	0.047	0.081

significance (critical F equals .056). The treatment effect appeared to vary as a function of gender. For example, DDAVP-treated females had 29.76% fewer errors than placebo-treated females, and DDAVP-treated males had 25.32% more errors than placebo-treated males. A significant treatment by response interaction, $F(1,80)=7.17$, $p=.01$ (See Figure 4), was also found. Subjects treated with placebo had a significantly higher error rate on negative responses; however, subjects treated with DDAVP did not differ significantly in regard to response type.

Significant interactions for gender by decision, $F(2,160)=6.51$, $p=.002$, and decision by response, $F(2,160)=3.72$, $p=.03$, were also indicated. Males made more errors on the physically identical decisions, whereas females had a higher rate of errors on same category decisions. The gender difference on same name decisions was not significant. The decision by response interaction resulted from a higher rate of errors on negative trials compared to positive trials for physically identical decisions. Error rates on positive and negative response types did not differ for the same name or same category decisions. No other 2 or 3 way interaction were significant.

Unexpected Free Recall

The proportion of words recalled from each subject's free recall was computed. The F max test with alpha set at .05 revealed heterogeneity of variance for the raw data; thus, the Arc sine transformation was subsequently completed on the raw data to
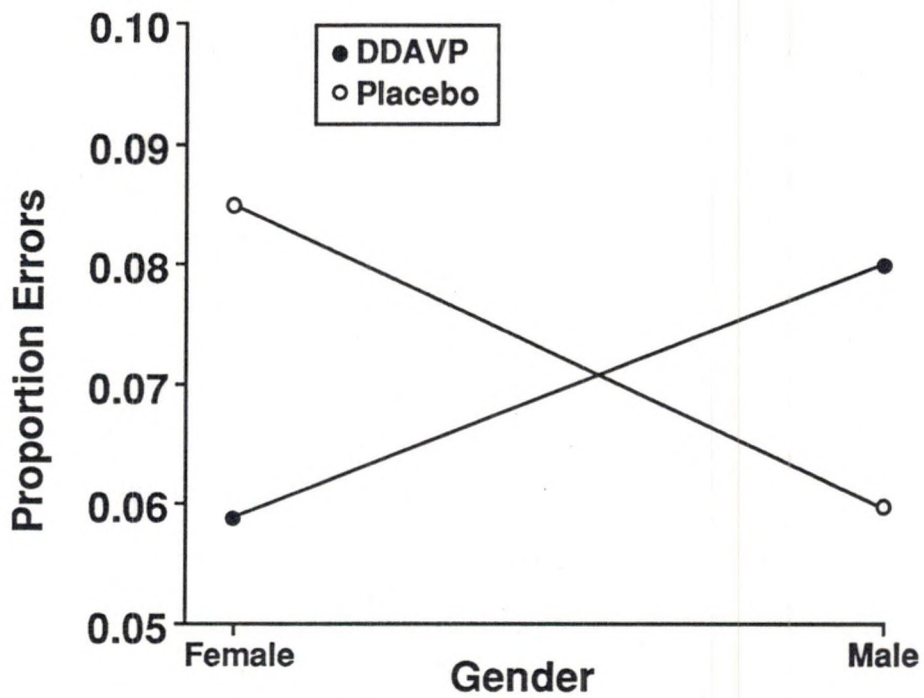
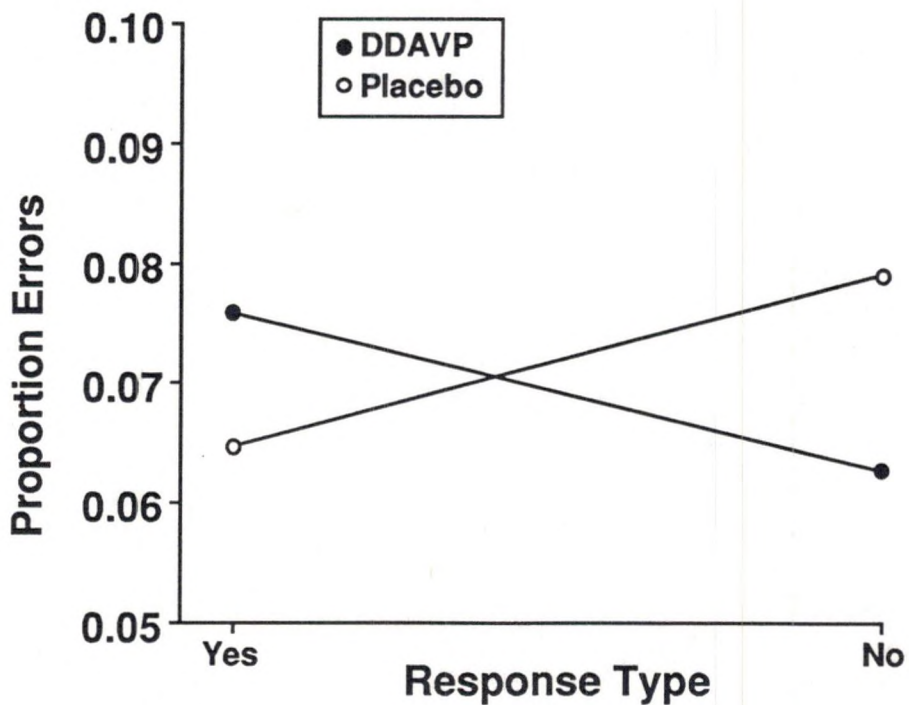Figure 3. Proportion of errors as a function of treatment and gender.

Figure 4. Proportion of errors as a function of treatment and decision type.

reduce heterogeneity of the variance. The transformed data were analyzed by means of a 2 (treatment) x 2 (gender) x 3 (decision type) x 2 (response type) analysis of variance with repeated measures on the last two factors. The ANOVA tables are presented in Appendix D (See Table 21). Means and standard deviations are presented in Table 10.

Table 10

Proportion Recall from Positive and Negative Experimental Trials for Subjects at Each Level of Treatment and Decision Type

	Positive			Negative		
	PI	SN	SC	PI	SN	SC
DDAVP						
M	0.152	0.135	0.197	0.086	0.065	0.118
SD	0.086	0.076	0.083	0.055	0.052	0.072
Placebo						
M	0.262	0.268	0.303	0.145	0.129	0.183
SD	0.941	0.938	0.457	0.469	0.470	0.466

The analysis of variance on proportion recall yielded no significant main effects of treatment, $F(1,79)=1.16$, $p=.29$, or gender, $F(1,79)<1$, $p>.50$. A main effect was found for decision, $F(2, 158)=39.91$, $p<.001$. Post-hoc testing revealed a significantly higher proportion of words recalled from the same category decision task than from the physically identical and the same name decision tasks.

A significant main effect for response type was found ($F(1,79)=100.61$, $p<.001$) in that subjects recalled a higher proportion of words from positive decision trials than from negative decision trials.

A significant decision type by response type interaction was also revealed, $F(2,158)=3.21$, $p=.04$. Subjects recalled a higher proportion of words from positive decision trials than from negative decision trials at all levels of decision, and subjects' recall was higher from same category trials compared to recall from same name or physically identical decision trials. For negative decision trials only, recall from physically identical decision trials was significantly higher than recall from same name decision trials. No other 2 or three way interactions were significant.

CHAPTER IV

DISCUSSION

Long-term Memory Access

Speed of accessing long-term memory was not affected by treatment with DDAVP. These results do not support the hypothesis that DDAVP improves the efficiency of working memory through speed of accessing long-term memory. There are several possible explanations for the lack of a treatment effect. First, the task may not be a valid estimate of accessing time; however, this conclusion does not seem likely as discussed below. Secondly, raw response time may measure more than the time necessary to access long-term memory (e.g. stimulus identification, response selection and response programming, as well as the motor component of the task); thus, the drug effect on long-term memory access may not be apparent. This perspective is discussed further in regard to analysis of the difference scores. Thirdly, the lack of a treatment effect may mean that there is no effect of DDAVP on speed of accessing long-term memory. In which case, other components of working memory may be responsible for the proposed increase in the efficiency of working memory, which is theorized to be responsible for enhanced recall of prose material.

Speed of accessing long-term memory as measured by response times did not differ in regard to gender. The lack of a gender effect is consistent with findings presented by Haut et al. (1989). In a study assessing the effect of acute intoxication with ethanol on speed of accessing long-term memory, no gender differences were found for sober subjects. Thus, speed of accessing long-term memory does not appear to differ simply as a function of gender.

Task effects including main effects for decision type and response type were found, as was a decision type by response type interaction. These task effects are consistent with levels of processing theory, as well as previous studies employing similar tasks. That is, deeper levels of processing require longer processing time (Craik and Lockhart, 1972). In the current study, semantic (same category) decisions required more processing time than lexical (same name) decisions, which required more processing time than decisions based on physical features (physically identical). This main effect for decision type has consistently been shown in previous studies (Rosch, 1975; Craik & Tulving, 1975; Chabot, Miller & Juola, 1976; Goldberg, Schwartz & Stewart, 1977; Petros, Zehr & Chabot, 1983; Haut et al., 1989).

Subjects responded more quickly to positive decisions than to negative decisions. This is also a standard task effect previously reported in the literature (Chabot et al., 1976; Petros et al., 1983; Haut et al., 1989). The finding that response times are shorter for same judgements than for different decisions has been termed the

"same/different effect" (Noordman-Vonk, 1979). Theorists have proposed a model to account for the same/different effect. The model suggests that subjects first try to find positive evidence with respect to the criterion in the task. If no positive evidence is found, a search for differences between the concepts is conducted. The decision type by response type interaction found in the present study, in which the same/different effect varied as a function of decision type, was also reported by Haut et al. (1989).

The consistency between results of previous literature using similar tasks and the present findings, as well as the congruence between these results and levels of processing theory suggest that the task is a valid measure of the speed of accessing long-term memory. The possibility remains that raw response time may include a multitude of processes which conceal a drug effect on accessing time. In an attempt to subtract the motor component of the task, as well as other cognitive components (e.g. stimulus identification, response selection and response programming) from the response time measures, a response time control task was implemented and later subtracted from the raw response times.

Response Time Control

The response time control (RTC) task was employed to assess the time required to complete the motor task of pressing a computer key, and thus aid in distinguishing the effect on memory produced by exposure to DDAVP from possible effects on the time required for the motor response. Analysis of the RTC data suggests that DDAVP

slowed reaction time for both the right and left hands, and that right handed responses were slower than left handed responses for DDAVP-treated subjects. Response time did not differ in regard to response handedness for subjects treated with the placebo.

Results of previous studies assessing the effect of DDAVP on reaction time are inconclusive. Millar et al. (1987) administered 40 ug of DDAVP to healthy young male subjects, and found no effect for a simple, unprepared visual reaction time task. The fact that 60 ug of DDAVP was found to retard reaction time in the present study is inconsistent with the nonsignificant findings of Millar et al.; however, the results may not be directly comparable, since the two studies used different doses of DDAVP, as well as a somewhat different task.

Another study which assessed the effects of chronic administration of 30 ug of DDAVP on numerous memory tasks, further investigated the effects of the neuropeptide on simple vocal reaction time and found no effect (Nebes et al., 1984). However, this reaction time task differed significantly from the present task in that it measured vocal latency from the onset of a stimulus, whereas the task employed in the present study measured motor response time from the offset of a stimulus. Furthermore, Nebes et al. employed chronic administration of a smaller dose of DDAVP, while the current study employed acute administration of a larger dose.

Results of the present study are also inconsistent with results of a recently published study assessing the effects of DDAVP on movement planning and execution processes in healthy young adults (Carter, Williams, Davis, Rotter & Clancy, 1991). Carter et al. reported that an acute dose of 60 ug of DDAVP decreased reaction time on both a simple reaction time task and a complex movement task. The effect of DDAVP on the simple reaction time task utilized by Carter et al. is most similar to the task employed in the current study. During this task, subjects were reportedly seated facing a motor sequencing apparatus with a warning/stimulus light placed on the top center. The subjects were instructed to depress the telegraph key with the index and third fingers of their dominant hand. A randomized forewarning period (1, 2 or 3 seconds in duration) was signaled by a white light, following which a red stimulus light appeared. In response to the stimulus light, subjects were instructed to respond by lifting the fingers as quickly as possible. DDAVP-treated subjects responded faster than subjects receiving the placebo.

Discrepant results between the study published by Carter et al. (1991) and the present study may be explained by the fact that subjects in the previous study responded with only the dominant hand, whereas subjects in the current study responded equally with the right and left hands. Additionally, the responses differed in that subjects in the current study were instructed to respond at the cessation of a stimulus, while Carter et al. instructed subjects to

respond at stimulus onset. It is also possible that the RTC task employed in the present study may not have been a true simple reaction time task. Reaction time is defined as the time from the appearance of a sudden and unanticipated signal to the beginning of a volitional motor response. Thus, reaction time encompasses the time required by the central nervous system for stimulus identification, response selection and response programming (Schmidt, 1985). By definition, response selection and programming are minimal in a simple reaction time task. The task used by Carter et al. (1990) attempted to minimize response selection and programming, whereas the RTC task utilized in the present study incorporated a three second forced delay during which response selection and programming were theorized to be complete. However, the discrepant results between the current study and the study reported by Carter et al. suggest that the task employed in the current study may have measured some of the cognitive processes which underlie response time, as well as the motor component of the task.

Difference Scores

Despite the uncertainty regarding the response time control data, difference scores were computed by subtracting RTC trials from the overall response times (median experimental data minus median response time control data from the corresponding cell of the design). If the RTC task does in fact capture the motor component of response time plus the time necessary for completion

of the cognitive processes involved in response selection and programming, then the difference scores should represent the time necessary to complete the remaining cognitive processes associated with each decision type (PI, SN, SC).

Similar to the results of the analysis of response times, analysis of the difference scores yielded no significant main effect for treatment with DDAVP, and response times did not differ in regard to gender. Task effects including main effects for decision type and response type were found, as was a decision type by response type interaction. As discussed above these are standard task effects, which have been reported by numerous authors (Rosch, 1975; Craik & Tulving, 1975; Chabot et al., 1976; Goldberg et al. , 1977; Petros et al., 1983; Haut et al., 1989).

Unique to the analysis of difference scores, was a significant treatment by decision interaction, such that DDAVP-treated subjects responded more quickly to physically identical decisions. The treatment effect was not apparent for decisions requiring either lexical access or category decisions. Goldberg et al. (1977) have speculated that physically identical decisions may require access to a different memory store than either homophone identity matching or taxonomic category identity matching. That is, physically identical decisions may require retrieval of information only from short-term memory. If this is in fact the case, then DDAVP may facilitate processing within short-term memory. This speculation is consistent with Pietrowsky et al.'s (1988) report that DGAVP

enhanced the recency effect, since the recency effect is classically seen as a measure of information maintenance within short-term memory (Ashcraft, 1989). Results suggesting that DDAVP facilitates short-term recall, while impairing long-term memory also appear consistent with the speculation that the present results indicate a facilitative effect specific to short-term memory (K. Millar, personal communication, March 25, 1988).

An alternative explanation suggests that physically identical decisions may actually require at least some access to lexicographically coded information stored in long-term memory (Goldberg et al., 1977). If this is true, theorists suggest that the data base involved is likely much less complex than the organization of the data bases containing phonemic and taxonomic information. Thus, DDAVP may facilitate retrieval of information from a less complicated organizational scheme within long-term memory. At this time no definite conclusion regarding whether the particular memory store involved in physically identical decisions is short-term or long-term memory can be rendered.

The fact that DDAVP was not found to facilitate access to semantic memory in the current study appears consistent with findings published by Millar et al. (1987) and Nebes et al. (1984). Millar et al.(1987) treated subjects with 40 ug of DDAVP and reported a nonsignificant treatment effect on decision latencies associated with semantic recognition. After 8 days of intranasal

DDAVP treatment, Nebes et al. (1984) found that treatment had no effect on semantic memory access.

Error Rates

Error rates are a difficult measure to interpret, and are typically seen as a secondary dependent variable. Rosch (1975) suggested that reaction time appears to be the appropriate variable for analysis, since subjects are encouraged to emphasize correctness in responses and since the practice trials tend to reduce the overall proportion of errors. Overall average error rates reported in previous studies range from 4% to 10.7% (Beller, 1971; Rosch, 1975; Chabot et al., 1976; Goldberg et al., 1977; Petros et al., 1983). The average overall error rate found in the current study was 7%. The correlation between response times and error rates, $r(502)=.29$, suggest that speed accuracy tradeoffs were not a problem in the data.

Although analysis of the proportion of errors did not yield a significant main effect for treatment or gender, significant treatment by response and treatment by gender interactions were found. Subjects treated with placebo had a significantly higher proportion of errors for negative decisions compared to positive decisions. Treatment with DDAVP appeared to eliminate the same/different effect for error rates.

The treatment by gender interaction indicated that females treated with DDAVP had a lower proportion of errors than placebo-treated females, whereas DDAVP-treated males had a higher

proportion of errors than males in the placebo-group. This result suggests that there may be a sexually dimorphic effect of the vasopressin analog. Differential treatment effects in regard to gender have been previously published. Beckwith et al. (1984) demonstrated enhanced sentence recall for males only, while Beckwith et al. (1990) found that acute treatment with DDAVP impaired color naming for female subjects only. Documented differential distributions of vasopressinergic neurons found in the developing rat brain (Swaab and Boer, 1983), as well as the CNS of adult male and female rats (Buijs, 1987), suggest that neurological differences may underlie gender-related performance differences in both nonhuman and human animals. The gender differences in response to treatment with DDAVP appear to be quite small and subtle.

Significant task effects found in the analysis of the error rates include a main effect for decision type and a decision type by response type interaction. Subjects made more errors on same category decisions than on same name decisions or physically identical decisions. This finding is consistent with the results reported by Chabot et al., 1976. Additionally, in the current study the proportion of errors on same name decisions was higher than the error rate for physically identical decisions. Haut et al. (1989) found the same pattern of results for positive decisions, but did not find a significant main effect of decision type for the negative trials. The significant decision type by response type interaction

found in the current study indicated that subjects made more errors on negative trials compared to positive trials for physically identical decisions. Error rates on positive and negative decisions did not differ for the same name or same category decisions.

In addition to the task effects, the analysis of error rates revealed a significant gender by decision type interaction such that males had a significantly higher proportion of errors on physically identical decisions, while females had significantly more errors on same category decisions. This finding is inconsistent with the results reported by Goldberg et al. (1977), which showed no gender differences in error rates for physically identical decisions. The authors did report a significant gender effect for homophone identity matching errors; males made significantly more errors at this level of decision.

Incidental Learning

Treatment with DDAVP did not affect proportion of recall. Since the recall was unexpected, the data suggest that this analog of vasopressin does not affect incidental learning from this orienting task. Results of previous studies utilizing the free recall paradigm and lists of words are inconclusive. Both Fehm-Wolfsdorf et al. (1984) and Beckwith et al. (1984) reported a nonsignificant treatment effect within the free recall paradigm. However, both Fehm-Wolfsdorf et al. (1983) and Pietrowsky et al. (1988) have shown that vasopressinergic analogs affect free recall of lists of words. Fehm-Wolfsdorf et al. (1983) reported a prolonged primacy

effect following treatment with LVP, and Pietrowsky et al. (1988) found that DGAVP attenuated the primacy effect and enhanced the recency effect.

While the current nonsignificant treatment effect is consistent with the results published by Fehm-Wolfsdorf et al. (1984) and Beckwith et al. (1984), the finding is inconsistent with the latter two studies. These results may not be directly comparable, however, since the current study employed incidental learning and the studies utilizing recall of lists of words examined intentional learning. Craik and Lockhart (1972, p. 677) suggest that "under incidental learning conditions, the experimenter has a control over the processing the subject applies to the material that he does not have when the subject is merely instructed to learn and uses an unknown coding strategy." Thus, DDAVP does not appear to affect memorial consequences specific to this orienting task, but may affect one or more other encoding strategies employed under intentional learning conditions.

Subjects' recall was not found to differ in regard to gender. Significant main effects for decision type and response type were found, as was a significant decision type by response type interaction. The task effects found in the current study are consistent with previous literature. A higher proportion of recall from same category decisions compared to recall from same name and physically identical decisions was found in the current study and has been reported by numerous authors (Rosch, 1975; Craik &

Tulving, 1975; Chabot et al., 1976; Goldberg et al., 1977). The main effect for decision type found in the analysis of the recall data is also consistent with levels of processing theory, which postulates that the durability of the memory trace is a function of depth of processing (Craik & Lockhart, 1972). Stimuli which are fully analyzed and enriched by associations or images result in a deeper encoding process, and a long-lasting memory trace, whereas stimuli which do not receive full attention, and are analyzed only at a shallow sensory level, produce transient memory traces.

The higher proportion recalled from positive decisions compared to the proportion recalled from negative decisions is also consistent with previous findings (Schulman, 1974; Craik & Tulving, 1975; Chabot et al., 1976). Craik and Tulving (1975) have suggested that the higher recall for positive decisions reflects a higher degree of encoding elaboration. For example, when a positive decision is made, the two stimuli form a coherent semantic unit with the category label; thus, forming an effective memory cue for later recall. When a negative decision is made, the unit is more complex and may contain two category labels resulting in a less effective memory cue. The decision by response interaction found in the current study was also reported by Craik and Tulving (1975); however, there was no further elaboration presented in the article. In the present study, subjects recalled significantly more words from physically identical decisions compared to same name decisions for negative trials only.

Conclusion

Although DDAVP did not affect speed of accessing long-term memory in a clear and concise manner, the vasopressin analog does appear to facilitate cognitive processes involving simple detection of physical features once the motor component of the task and some of the cognitive processes involved in response selection and programming are removed. In attempting to relate these findings to the results of a previous study assessing the effects of DDAVP on recall of narrative prose (Beckwith et al., 1987), one might speculate that in the narrative prose situation the DDAVP-treated subject's detection of simple physical features is made more efficient; thus leaving more time for the more elaborate processing involved in the comprehension of a narrative prose passage. If, in fact, more time and attention were focused on the more elaborate processes, then a higher recall of more deeply processed information as shown by Beckwith et al. (1987) would be expected. These authors found that DDAVP facilitated recall of idea units within the passages of both high and medium levels of importance. DDAVP had no influence on recall of idea units at the low level of importance. The authors interpret these results as evidence that DDAVP "may have facilitated the divided attentional processes necessary to integrate text in working memory as evidenced by the increased attention to relevant as opposed to irrelevant details of the passages presented" (p.431). The present speculations are also consistent with this interpretation. Replication of the study with a

simpler reaction time control task measuring the pure motor component of response time is warranted.

Additionally, analysis of the error rates suggests a subtle sexually dimorphic effect of the peptide analog. Again, this effect is not easily interpreted, but seems to suggest a facilitation in accuracy for DDAVP-treated female subjects, and an adverse effect in regard to error rates for DDAVP-treated male subjects. Sexually dimorphic effects appear likely in view of animal studies which report a sexually dimorphic effect of AVP on retention of a passive-avoidance response (Tinius et al., 1987; Swenson et al., 1990) and human studies reporting sexually dimorphic effects on human cognition (Beckwith et al., 1985; 1990).

Since all female subjects employed in the current study participated during the first five days of their menstrual cycles and were not taking oral contraceptives, the generalizability of the present findings are somewhat limited. It may be beneficial to focus further research efforts on various stages of the menstrual cycle, since the neurochemical substrate underlying the mechanisms of drug action have been found to vary across the menstrual cycle (Hamilton, 1986) and since cognitive and motor skills appear to be effected by normal physiological variations in gonadal hormones (Hampson, 1990).

In view of the clinical implications and previous studies reporting facilitative effects on memory, the subtle effects of DDAVP on accessing long-term memory deserve further research

attention. Future research utilizing the category judgement task should include a simple reaction time task, which would give a truer estimate of the motor component of the task. In addition, possible sexually-dimorphic effects of the peptide analog have obvious clinical significance warranting further attention.

APPENDICES

APPENDIX A

SCREENING QUESTIONAIRE

Please answer the following questions carefully. All information provided will remain confidential. Your honest responses will determine your suitability for participation in research. If you wish you may leave answers blank, however this may preclude your participation in the study. Please estimate as accurately as possible when answering all questions. Feel free to add any comments you may have at any place on the questionnaire. If you indicate you are willing to participate, you will be called at a future date. Thank you for your participation.

Name_____ Sex   M   F   (circle one)

Age_____

Birthdate_____

Weight (lbs.)_____

Height_____ft._____in.

Phone (Day)_____

(Evening)_____

Best times to reach by phone _____

Please circle the most appropriate number on the line following each statement.

1. I drink coffee (If you answer "never," skip to question 4).

1	2	3	4	5	6	7
never	less than one day a month	at least one day a month	1-2 days a week	3-4 days a week	5-6 days a week	daily

2. On days I drink coffee, I average

1	2	3	4	5	6	7
1 cup	2 cups	3-4 cups	5-6 cups	7-8 cups	9-10 cups	> 10 cups

3. I drink decaffeinated coffee

1	2	3	4	5	6	7
never	less than 1/4 the time	less than 1/2 the time	1/2 the time	more than 1/2 the time	more than 3/4 the time	daily

4. I drink beer (If you answer "never," skip to question 8).

1	2	3	4	5	6	7
never	less than one day a month	at least one day a month	1-2 days a week	3-4 days a week	5-6 days a week	daily

5. On days I drink beer, I average

1	2	3	4	5	6	7
1 drink	2 drinks	3-4 drinks	5-6 drinks	7-8 drinks	9-10 drinks	> 10 drinks

6. On days I drink beer, I drink at least

1	2	3	4	5	6	7
1 drink	2 drinks	3-4 drinks	5-6 drinks	7-8 drinks	9-10 drinks	> 10 drinks

7. On days I drink beer, the most I drink is

1	2	3	4	5	6	7
1 drink	2 drinks	3-4 drinks	5-6 drinks	7-8 drinks	9-10 drinks	> 10 drinks

8. I drink wine (If you answer "never," skip to question 12).

1	2	3	4	5	6	7
never	less than one day a month	at least one day a month	1-2 days a week	3-4 days a week	5-6 days a week	daily

9. On days I drink wine, I average

1	2	3	4	5	6	7
1 drink	2 drinks	3-4 drinks	5-6 drinks	7-8 drinks	9-10 drinks	> 10 drinks

10. On days I drink wine, I drink at least

1	2	3	4	5	6	7
1 drink	2 drinks	3-4 drinks	5-6 drinks	7-8 drinks	9-10 drinks	> 10 drinks

11. On days I drink wine, the most I drink is

1	2	3	4	5	6	7
1 drink	2 drinks	3-4 drinks	5-6 drinks	7-8 drinks	9-10 drinks	> 10 drinks

12. I drink alcoholic beverages other than beer and wine (e.g. scotch, vodka, rum, whiskey, etc.)
(If you answer "never," skip to question 16.)

1	2	3	4	5	6	7
never	less than one day a month	at least one day a month	1-2 days a week	3-4 days a week	5-6 days a week	daily

13. On days I drink alcoholic beverages other than beer or wine, average

1	2	3	4	5	6	7
1 drink	2 drinks	3-4 drinks	5-6 drinks	7-8 drinks	9-10 drinks	> 10 drinks

14. On days I drink alcoholic beverages other than beer or wine, I drink at least

1	2	3	4	5	6	7
1 drink	2 drinks	3-4 drinks	5-6 drinks	7-8 drinks	9-10 drinks	> 10 drinks

15. On days I drink alcoholic beverages other than beer or wine, I drink at most

1	2	3	4	5	6	7
1 drink	2 drinks	3-4 drinks	5-6 drinks	7-8 drinks	9-10 drinks	> 10 drinks

16. I drink soda pop (cola, rootbeer, etc.)

1	2	3	4	5	6	7
never	less than one day a month	at least one day a month	1-2 days a week	3-4 days a week	5-6 days a week	daily

17. On days I drink soda pop, I average

1	2	3	4	5	6	7
1 drink	2 drinks	3-4 drinks	5-6 drinks	7-8 drinks	9-10 drinks	> 10 drinks

18. I drink decaffeinated soda pop

1	2	3	4	5	6	7
never	less than 1/4 the time	less than 1/2 the time	1/2 the time	more than 1/2 the time	more than 3/4 the time	daily

19. I smoke tobacco (e.g. cigarettes, pipe, cigars)

1	2	3	4	5	6	7
never	less than one day a month	at least one day a month	1-2 days a week	3-4 days a week	5-6 days a week	daily

20. On days I smoke, I average

1	2	3	4	5	6	7
1 smoke	2 smokes	3-4 smokes	5-6 smokes	7-8 smokes	9-10 smokes	> 10 smokes

21. I chew tobacco or snuff

1	2	3	4	5	6	7
never	less than one day a month	at least one day a month	1-2 days a week	3-4 days a week	5-6 days a week	daily

22. On days I chew, I average

1	2	3	4	5	6	7
1 snuff	2 snuffs	3-4 snuffs	5-6 snuffs	7-8 snuffs	9-10 snuffs	> 10 snuffs

23. I use a recreational drug which is not mentioned above

1	2	3	4	5	6	7
never	less than one day a month	at least one day a month	1-2 days a week	3-4 days a week	5-6 days a week	daily

24. My health in the last year has been

1	2	3	4	5	6	7
very poor	poor	below average	average	above average	good	very good

Please answer the following questions ("yes" or "no"). If you answer "yes" to any question please describe when it occurred and any other relevant details.

25. Have you ever had high blood pressure?

Yes_____   Comments:_____

No_____

26. Have you ever had allergies?

    Yes_____   Comments:_____

    No_____

27. Have you ever had ulcers?

    Yes_____   Comments:_____

    No_____

28. Have you ever had cardio-vascular disease?

    Yes_____   Comments:_____

    No_____

29. Have you ever had epilepsy?

    Yes_____   Comments:_____

    No_____

30. Have you ever received treatment for overuse of alcohol or other drugs?

    Yes_____   Comments:_____

    No_____

31. Are you currently taking any vitamins?

    Yes_____   No_____

If yes, please list vitamins, reason for taking vitamins, and the length of time the vitamin has been taken.

32. Are you currently taking any prescription medications?

     Yes_____   No_____

If yes: a.) What is the name of the medication?

         b.) For what do you use the medication?

         c.) When did you start taking the medication?

33. Have you taken any prescription medications in the last five years that you are not currently taking?

     Yes_____   No_____

If yes: a.) What are the names of the medications?

         b.) Why did you take the medications?

         c.) When did you start taking the medications?

         d.) When did you stop taking the medications?

34. Are you currently taking over-the-counter medications (e.g., Vicks, Ni-Quil, antihistamines, etc.)?

     Yes_____   No_____

If yes: a.) What is the name of the medication?

         b.) For what do you use the medication?

         c.) When did you start taking the medication?

37. Would you be willing to participate in a study of the effects of vasopressin on memory?

   Yes_____ No_____ Not sure at this time_____

FEMALES ONLY:

38. Are you currently pregnant?

   Yes_____   No_____

39. Are you currently attempting to become pregnant?

   Yes_____   No_____

40. Are you currently taking oral contraceptives?

   Yes_____   No_____

41. If you are not currently taking oral contraceptives, have you ever taken oral contraceptives?

   Yes_____   No_____

If yes, how long has it been since you discontinued use of oral contraceptives?

WORD LISTS

Sequence 1

Physically Identical - Same

ORANGE	1		ORANGE	1
watermelon	23		watermelon	23
bluejay	3		bluejay	3
nightgown	21		nightgown	21
cardinal	17.5		cardinal	17.5
DRESSER	6.5		DRESSER	6.5
FOOTBALL	1		FOOTBALL	1
toolbox	14		toolbox	14
wrench	23		wrench	23
HONDA	12		HONDA	12
AIRPLANE	18		AIRPLANE	18
switchblade	6		switchblade	6
BUREAU	14		BUREAU	14
shotgun	9		shotgun	9
SWEATSHIRT	11		SWEATSHIRT	11
VOLLEYBALL	14		VOLLEYBALL	14
	sum=194			sum=194
	X=12.1			X=12.1

71

Physically Identical - Different

pants	1	automobile	1
buffet	30	ladder	24
BANANA	3	BLACKBIRD	6
vanity	21	swimming	11
APPLE	2	TAXI	5.5
pliers	22	tomahawk	23
TENNIS	4	TANGERINE	6.5
underpants	12	track	12
BUS	5.5	DAGGER	8
trailer	27	cabinet	27
knife	7	PARAKEET	10
ARROW	25	LAMP	31
drill	5	nectarine	10
DOVE	7	SCREWDRIVER	4
REDBIRD	13.5	SLACKS	7
hockey	9	jacket	8
	sum=194		sum=194
	X=12.1		X=12.1

Same Name - Same

GRAPEFRUIT	12	grapefruit	12
ORIOLE	11	oriole	11
basketball	3	BASKETBALL	3
BOXING	13	boxing	13
APRICOT	6.5	apricot	6.5
eagle	17.5	EAGLE	17.5
couch	3.5	COUCH	3.5
boat	20	BOAT	20
table	3.5	TABLE	3.5
JET	21	jet	21
PAJAMAS	18	pajamas	18
PARKA	17	parka	17
club	19	CLUB	19
RIFLE	5	rifle	5
level	11	LEVEL	11
file	13	FILE	13
	sum=194		sum=194
	X=12.1		X=12.1

Same Name - Different

SPARROW	2		dress	2.5
mockingbird	12		BERRY	13
RULER	3		revolver	3
bench	21		POLO	18
handball	7		JEEP	7
GOLF	17		footstool	26
PISTOL	2		robin	1
ambulance	8		CANOEING	6
bicycle	16		BLUEBERRY	18
MELON	17		chest	19
CHERRY	14		panties	14.5
bazooka	16		CARRIAGE	17
divan	17		PENCIL	18
ottoman	25		CANNON	17
SHIRT	2.5		nails	6
JUMPER	14.5		lark	8
	sum=194			sum=194
	X=12.1			X=12.1

Same Category - Same

CHAIR	1.5		SOFA	1.5
CRICKET	22.5		SQUASH	22.5
truck	3		car	4
HUMMINGBIRD	19		PIGEON	22
bluebird	4		CANARY	5
wrestling	20		surfing	19
SUIT	6		blouse	5
OVERCOAT	20		undershirt	19
sword	10		BOMB	11.5
spear	15		BAYONET	13.5
van	11		streetcar	10
DESK	12		BED	13
PLUM	8		grapes	9
BLACKBERRY	16		pineapple	15
sandpaper	9		sawhorse	8
RASP	17		chisel	16
	sum=194			sum=194
	X=12.1			X=12.1

Same Category - Different

GUN	1		SAW	1
MORTAR	24		lounge	23
hammer	2		baseball	2
bookcase	22		BULLET	22
PEACH	4		SKIRT	4
LEMON	20		LANCE	20
bike	19		hacksaw	19
softball	5		PEAR	5
rugby	8		coat	9
socks	16		STARLING	16
sweater	10		rocker	9
FINCH	15		lacrosse	15
WREN	13.5		trolley	15
SANDER	10		STRAWBERRY	11
motorcycle	9		SWALLOW	9
davenport	15.5		TRAIN	14

sum=194   sum=194

X=12.1   X=12.1

Sequence 2

Physically   Identical-Same

CHAIR	1.5		CHAIR	1.5
CRICKET	22.5		CRICKET	22.5
TRUCK	3		TRUCK	3
hummingbird	19		hummingbird	19
bluebird	4		bluebird	4
WRESTLING	20		WRESTLING	20
suit	6		suit	6
OVERCOAT	20		OVERCOAT	20
sword	10		sword	10
spear	15		spear	15
VAN	11		VAN	11
DESK	12		DESK	12
PLUM	8		PLUM	8
blackberry	16		blackberry	16
sandpaper	9		sandpaper	9
rasp	17		rasp	17
	sum=194			sum=194
	X=12.1			X=12.1

Physically   Identical-Different

GUN	1	SAW	1
MORTAR	24	LOUNGE	23
hammer	2	baseball	2
bookcase	22	bullet	22
PEACH	4	SKIRT	4
LEMON	20	LANCE	20
bike	19	hacksaw	10
softball	5	pear	5
RUGBY	8	COAT	9
socks	16	starling	16
sweater	10	rocker	9
FINCH	15	LACROSSE	15
WREN	13.5	TROLLEY	15
sander	10	strawberry	11
MOTORCYCLE	9	SWALLOW	9
davenport	15.5	train	14

<div align="center">

sum=194
X=12.1

</div>

<div align="right">

sum=194
X=12.1

</div>

Same Name-Same

SOFA	1.5	sofa	1.5
SQUASH	22.5	squash	22.5
car	4	CAR	4
PIGEON	22	pigeon	22
CANARY	5	canary	5
surfing	19	SURFING	19
BLOUSE	5	blouse	5
undershirt	19	UNDERSHIRT	19
BOMB	11.5	bomb	11.5
bayonet	13.5	BAYONET	13.5
streetcar	10	STREETCAR	10
BED	13	bed	13
GRAPES	9	grapes	9
pineapple	15	PINEAPPLE	15
sawhorse	8	SAWHORSE	8
CHISEL	16	chisel	16

<div align="center">

sum=194
X=12.1

</div>

<div align="right">

sum=194
X=12.1

</div>

Same Name-Different

pants	1
BUFFET	30
BANANA	3
vanity	21
apple	2
PLIERS	22
TENNIS	4
UNDERPANTS	12
BUS	5.5
trailer	27
knife	7
ARROW	25
drill	5
dove	7
REDBIRD	13.5
hockey	9

sum=194
X=12.1

AUTOMOBILE	1
ladder	24
blackbird	6
SWIMMING	11
TAXI	5.5
tomahawk	23
tangerine	6.5
TRACK	12
dagger	8
CABINET	27
PARAKEET	10
lamp	31
NECTARINE	10
screwdriver	4
slacks	7
JACKET	8

sum=194
X=12.1

Same Category-Same

orange	2
watermelon	23
BLUEJAY	3
NIGHTGOWN	21
cardinal	17.5
dresser	6.5
FOOTBALL	1
toolbox	14
wrench	23
HONDA	12
airplane	18
SWITCHBLADE	6
BUREAU	14
shotgun	9
SWEATSHIRT	11
VOLLEYBALL	14

sum=194
X=12.1

APRICOT	6.5
GRAPEFRUIT	12
oriole	11
pajamas	18
eagle	17.5
couch	3.5
BASKETBALL	3
level	11
file	13
BOAT	20
jet	21
RIFLE	5
TABLE	3.5
CLUB	19
PARKA	17
boxing	13

sum=194
X=12.1

Same Category-Different

sparrow	2	DRESS	2.5
MOCKINGBIRD	12	BERRY	13
ruler	3	revolver	3
bench	21	polo	18
handball	7	JEEP	7
GOLF	17	FOOTSTOOL	26
BAZOOKA	16	carriage	17
PISTOL	2	robin	1
AMBULANCE	8	canoeing	6
bicycle	16	blueberry	18
melon	17	CHEST	19
CHERRY	14	PANTIES	14.5
divan	17	PENCIL	18
ottoman	25	CANNON	17
SHIRT	2.5	nails	6
JUMPER	14.5	lark	8
	sum=194		sum=194
	X=12.1		X=12.1

Physically   Identical-Same

SOFA	1.5		SOFA	1.5
SQUASH	22.5		SQUASH	22.5
car	4		car	4
pigeon	22		pigeon	22
canary	5		canary	5
surfing	19		surfing	19
BLOUSE	5		BLOUSE	5
undershirt	19		undershirt	19
bomb	11.5		bomb	11.5
bayonet	13.5		bayonet	13.5
streetcar	10		streetcar	10
BED	13		BED	13
GRAPES	9		GRAPES	9
PINEAPPLE	15		PINEAPPLE	15
SAWHORSE	8		SAWHORSE	8
CHISEL	16		CHISEL	16
	sum=194			sum=194
	X=12.1			X=12.1

Physically   Identical-Different

SPARROW	2		DRESS	2.5
MOCKINGBIRD	12		BERRY	13
RULER	3		REVOLVER	3
bench	21		polo	18
HANDBALL	7		JEEP	7
golf	17		footstool	26
BAZOOKA	16		CARRIAGE	17
pistol	2		robin	1
ambulance	8		canoeing	6
bicycle	16		blueberry	18
MELON	17		CHEST	19
cherry	14		panties	14.5
DIVAN	17		PENCIL	18
OTTOMAN	25		CANNON	17
shirt	2.5		nails	6
jumper	14.5		lark	8
	sum=194			sum=194
	X=12.1			X=12.1

Same Name-Same

chair	1.5		CHAIR	1.5
cricket	22.5		CRICKET	22.5
truck	3		TRUCK	3
hummingbird	19		HUMMINGBIRD	19
bluebird	4		BLUEBIRD	4
WRESTLING	20		wrestling	20
SUIT	6		suit	6
OVERCOAT	20		overcoat	20
sword	10		SWORD	10
SPEAR	15		spear	15
van	11		VAN	11
DESK	12		desk	12
plum	8		PLUM	8
BLACKBERRY	16		blackberry	16
sandpaper	9		SANDPAPER	9
RASP	17		rasp	17
	sum=194			sum=194
	X=12.1			X=12.1

Same Name-Different

GUN	1	saw	1
mortar	24	LOUNGE	23
hammer	2	BASEBALL	2
BOOKCASE	22	bullet	22
peach	4	SKIRT	4
lemon	20	LANCE	20
bike	19	HACKSAW	19
SOFTBALL	5	pear	5
RUGBY	8	coat	9
SOCKS	16	starling	16
sweater	10	ROCKER	9
finch	15	LACROSSE	15
WREN	13.5	trolley	15
sander	10	STRAWBERRY	11
MOTORCYCLE	9	swallow	9
DAVENPORT	15.5	train	14
	sum=194		sum=194
	X=12.1		X=12.1

Same Category-Same

APRICOT	6.5	orange	1
GRAPEFRUIT	12	watermelon	23
oriole	11	BLUEJAY	3
PAJAMAS	18	nightgown	21
EAGLE	17.5	CARDINAL	17.5
COUCH	3.5	DRESSER	6.5
BASKETBALL	3	FOOTBALL	1
LEVEL	11	toolbox	14
file	13	wrench	23
boat	20	honda	12
jet	21	airplane	18
rifle	5	SWITCHBLADE	6
TABLE	3.5	BUREAU	14
club	19	SHOTGUN	9
PARKA	17	sweatshirt	11
boxing	13	volleyball	14
	sum=194		sum=194
	X=12.1		X=12.1

Same   Category-Different

pants	1		automobile	1
buffet	30		LADDER	24
BANANA	3		BLACKBIRD	6
vanity	21		SWIMMING	11
APPLE	2		TAXI	5.5
PLIERS	22		TOMAHAWK	23
tennis	4		tangerine	6.5
underpants	12		TRACK	12
bus	5.5		DAGGER	8
trailer	27		cabinet	27
KNIFE	7		parakeet	10
ARROW	5		LAMP	31
drill	5		nectarine	10
DOVE	7		screwdriver	4
REDBIRD	13.5		slacks	7
hockey	9		JACKET	8
	sum=194			sum=194
	X=12.1			X=12.1

Sequence 4

Physically   Identical-Same

PANTS	1		PANTS	1
buffet	30		buffet	30
banana	3		banana	3
vanity	1		vanity	21
APPLE	2		APPLE	2
pliers	22		pliers	22
TENNIS	4		TENNIS	4
underpants	12		underpants	12
BUS	5.5		BUS	5.5
trailer	27		trailer	27
KNIFE	7		KNIFE	7
arrow	25		arrow	25
DRILL	5		DRILL	5
DOVE	7		DOVE	7
REDBIRD	13.5		REDBIRD	13.5
HOCKEY	9		HOCKEY	9
	sum=194			sum=194
	X=12.1			X=12.1

Physically   Identical-Different

VOLLEYBALL	14
sweatshirt	11
SHOTGUN	9
bureau	14
switchblade	6
AIRPLANE	18
honda	12
WRENCH	23
toolbox	14
football	1
DRESSER	6.5
cardinal	17.5
NIGHTGOWN	21
BLUEJAY	3
WATERMELON	23
orange	1

sum=194
X=12.1

NECTARINE	10
dagger	8
SLACKS	7
swimming	11
blackbird	6
TOMAHAWK	23
jacket	8
LAMP	31
parakeet	10
screwdriver	4
TANGERINE	6.5
track	12
LADDER	24
TAXI	5.5
CABINET	27
automobile	1

sum=194
X=12.1

Same Name-Same

SPARROW	2
mockingbird	12
RULER	3
bench	21
handball	7
GOLF	17
bazooka	16
PISTOL	2
ambulance	8
BICYCLE	16
melon	17
CHERRY	14
DIVAN	17
ottoman	25
shirt	2.5
JUMPER	14.5

sum=194
X=12.5

sparrow	2
MOCKINGBIRD	12
ruler	3
BENCH	21
HANDBALL	7
golf	17
BAZOOKA	16
pistol	2
AMBULANCE	8
bicycle	16
MELON	17
cherry	14
divan	17
OTTOMAN	25
SHIRT	2.5
jumper	14.5

sum=194
X=12.5

Same Name-Different

grapefruit	12		PANTIES	14.5
oriole	11		JEEP	7
BASKETBALL	3		ROBIN	1
BOXING	13		berry	13
APRICOT	6.5		nails	6
EAGLE	17.5		polo	18
couch	3.5		DRESS	2.5
BOAT	20		chest	19
TABLE	3.5		revolver	3
jet	21		FOOTSTOOL	26
pajamas	18		PENCIL	18
PARKA	17		carriage	17
club	19		blueberry	18
rifle	5		CANOEING	6
level	11		LARK	8
FILE	13		cannon	17

	sum=194			sum=194
	X=12.5			X=12.5

Same Category-Same

gun	1		lance	20
MORTAR	24		bullet	22
hammer	2		SAW	1
bookcase	22		lounge	23
peach	4		pear	5
lemon	20		strawberry	11
bike	19		TROLLEY	15
SOFTBALL	5		BASEBALL	2
RUGBY	8		lacrosse	15
socks	16		coat	9
SWEATER	10		SKIRT	4
FINCH	15		STARLING	16
WREN	13.5		SWALLOW	9
sander	10		HACKSAW	19
motorcycle	9		TRAIN	14
DAVENPORT	15.5		ROCKER	9

	sum=194			sum=194
	X=12.5			X=12.5

Same   Category-Different

chair	1.5	car	4
CRICKET	22.5	undershirt	19
TRUCK	3	sofa	1.5
HUMMINGBIRD	19	surfing	19
BLUEBIRD	4	BLOUSE	5
wrestling	20	pigeon	22
suit	6	CANARY	5
overcoat	20	SQUASH	22.5
SWORD	10	streetcar	10
SPEAR	15	chisel	16
VAN	11	BOMB	11.5
desk	12	bayonet	13.5
PLUM	8	sawhorse	8
BLACKBERRY	16	BED	13
sandpaper	9	GRAPES	9
rasp	17	PINEAPPLE	15

        sum=194   sum=194

        X=12.5   X=12.5

Physically   Identical-Same

GUN	1		GUN	1
mortar	24		mortar	24
hammer	2		hammer	2
bookcase	22		bookcase	22
peach	4		peach	4
LEMON	20		LEMON	20
BIKE	19		BIKE	19
SOFTBALL	5		SOFTBALL	5
rugby	8		rugby	8
socks	16		socks	16
SWEATER	10		SWEATER	10
finch	15		finch	15
WREN	13.5		WREN	13.5
sander	10		sander	10
MOTORCYCLE	9		MOTORCYCLE	9
DAVENPORT	15.5		DAVENPORT	15.5
	sum=194			sum=194
	X=12.5			X=12.5

Physically   Identical-Different

chair	1.5		car	4
cricket	22.5		undershirt	19
TRUCK	3		SOFA	1.5
HUMMINGBIRD	19		SURFING	19
BLUEBIRD	4		BLOUSE	5
WRESTLING	20		PIGEON	22
suit	6		canary	5
overcoat	20		squash	22.5
SWORD	10		STREETCAR	10
SPEAR	15		CHISEL	16
van	11		bomb	11.5
desk	12		bayonet	13.5
PLUM	8		SAWHORSE	8
blackberry	16		bed	13
SANDPAPER	9		GRAPES	9
rasp	7		pineapple	15
	sum=194			sum=194
	X=12.5			X=12.5

Same Name-Same

LANCE	20		lance	20
bullet	22		BULLET	22
SAW	1		saw	1
lounge	23		LOUNGE	23
pear	5		PEAR	5
STRAWBERRY	11		strawberry	11
TROLLEY	15		trolley	15
BASEBALL	2		baseball	2
lacrosse	15		LACROSSE	15
COAT	9		coat	9
SKIRT	4		skirt	4
starling	16		STARLING	16
swallow	9		SWALLOW	9
hacksaw	16		HACKSAW	16
train	14		TRAIN	14
ROCKER	9		rocker	9
	sum=194			sum=194
	X=12.5			X=12.5

Same Name-Different

volleyball	14		NECTARINE	10
SWEATSHIRT	11		dagger	8
SHOTGUN	9		slacks	7
bureau	14		SWIMMING	11
SWITCHBLADE	6		blackbird	6
airplane	18		TOMAHAWK	23
HONDA	12		jacket	8
WRENCH	23		lamp	31
toolbox	14		PARAKEET	10
football	1		SCREWDRIVER	4
DRESSER	6.5		tangerine	6.5
CARDINAL	17.5		track	12
nightgown	21		LADDER	24
bluejay	3		TAXI	5.5
watermelon	23		CABINET	27
ORANGE	1		automobile	1
	sum=194			sum=194
	X=12.5			X=12.5

Same Category-Same

HOCKEY	9		golf	17
redbird	13.5		mockingbird	12
DOVE	7		SPARROW	2
drill	5		RULER	3
arrow	25		bazooka	16
KNIFE	7		PISTOL	2
trailer	27		BICYCLE	16
BUS	5.5		AMBULANCE	8
UNDERPANTS	12		jumper	14.5
TENNIS	4		handball	7
PLIERS	22		BENCH	21
apple	2		cherry	14
vanity	21		divan	17
banana	3		OTTOMAN	25
pants	1		SHIRT	2.5
buffet	30		MELON	17
	sum=194			sum=194
	X=12.5			X=12.5

Same   Category-Different

GRAPEFRUIT	12	PANTIES	14.5
ORIOLE	11	JEEP	7
basketball	3	robin	1
boxing	13	BERRY	13
APRICOT	6.5	nails	6
eagle	17.5	polo	18
COUCH	3.5	dress	2.5
BOAT	20	CHEST	19
table	3.5	revolver	3
JET	21	FOOTSTOOL	26
PAJAMAS	18	pencil	18
PARKA	17	carriage	17
club	19	blueberry	18
RIFLE	5	canoeing	6
level	11	LARK	8
file	13	CANNON	17

sum=194   sum=194

X=12.5   X=12.5

Physically   Identical-Same

LANCE	20		LANCE	20
bullet	22		bullet	22
saw	1		saw	1
LOUNGE	23		LOUNGE	23
PEAR	5		PEAR	5
strawberry	11		strawberry	11
trolley	15		trolley	15
BASEBALL	2		BASEBALL	2
lacrosse	15		lacrosse	15
coat	9		coat	9
SKIRT	4		SKIRT	4
starling	16		starling	16
SWALLOW	9		SWALLOW	9
HACKSAW	19		HACKSAW	19
TRAIN	14		TRAIN	14
rocker	9		rocker	9
	sum=194			sum=194
	X=12.5			X=12.5

Physically   Identical-Different

GRAPEFRUIT	12		PANTIES	14.5
ORIOLE	11		JEEP	7
BASKETBALL	3		ROBIN	1
boxing	13		berry	13
APRICOT	6.5		NAILS	6
eagle	17.5		polo	18
COUCH	3.5		DRESS	2.5
BOAT	20		CHEST	19
table	3.5		revolver	3
jet	21		footstool	26
PAJAMAS	18		PENCIL	18
PARKA	17		CARRIAGE	17
club	19		blueberry	18
rifle	5		canoeing	6
level	11		lark	8
file	13		cannon	17

sum=194 X=12.5 (left) sum=194 X=12.5 (right)

Same Name-Same

gun	1		GUN	1
MORTAR	24		mortar	24
HAMMER	2		hammer	2
BOOKCASE	22		bookcase	22
PEACH	4		peach	4
lemon	20		LEMON	20
BIKE	19		bike	19
SOFTBALL	5		softball	5
rugby	8		RUGBY	8
socks	16		SOCKS	16
SWEATER	10		sweater	10
finch	15		FINCH	15
wren	13.5		WREN	13.5
sander	10		SANDER	10
MOTORCYCLE	9		motorcycle	9
davenport	15.5		DAVENPORT	15.5

sum=194 X=12.5 (left) sum=194 X=12.5 (right)

Same Name-Different

CHAIR	1.5		CAR	4
cricket	22.5		UNDERSHIRT	19
truck	3		SOFA	1.5
HUMMINGBIRD	19		surfing	19
bluebird	4		BLOUSE	5
wrestling	20		PIGEON	22
SUIT	6		canary	5
overcoat	20		SQUASH	22.5
sword	10		STREETCAR	10
SPEAR	15		chisel	16
VAN	11		bomb	11.5
DESK	12		bayonet	13.5
plum	8		sawhorse	8
blackberry	16		BED	13
sandpaper	9		GRAPES	9
RASP	17		pineapple	15
	sum=194			sum=194
	X=12.5			X=12.5

Same Category-Same

PANTS	1		shirt	2.5
BUFFET	30		ottoman	25
BANANA	3		melon	17
vanity	21		divan	17
APPLE	2		BENCH	21
TENNIS	4		HANDBALL	7
underpants	12		JUMPER	14.5
bus	5.5		AMBULANCE	8
TRAILER	27		bicycle	16
knife	7		pistol	2
arrow	25		bazooka	16
drill	5		ruler	3
DOVE	7		SPARROW	2
REDBIRD	13.5		MOCKINGBIRD	12
hockey	9		GOLF	17
pliers	22		cherry	14
	sum=194			sum=194
	X=12.5			X=12.5

Same Category-Different

volleyball	14	nectarine	10
sweatshirt	11	DAGGER	8
SHOTGUN	9	SLACKS	7
BUREAU	14	swimming	11
SWITCHBLADE	6	BLACKBIRD	6
AIRPLANE	18	TOMAHAWK	23
honda	12	jacket	8
WRENCH	23	LAMP	31
toolbox	14	PARAKEET	10
football	1	screwdriver	4
dresser	6.5	tangerine	6.5
CARDINAL	17.5	TRACK	12
nightgown	21	LADDER	24
BLUEJAY	3	taxi	5.5
WATERMELON	23	cabinet	27
orange	1	automobile	1

sum=194   sum=194

X=12.5   X=12.5

INFORMED CONSENT FORM

Information About and Consent for participation in Study Entitled:
Effects of Vasopressin on the Category Judgement

The purpose of this study is to examine the effects of vasopressin on cognitive functioning (i.e. memory) in healthy college students. You have been chosen to participate in this study based on your responses to the screening questionnaire, which you completed earlier this semester. Your participation is voluntary. You will be asked to inhale a normal therapeutic dose (60 micrograms) of vasopressin (desmopressin acetate or DDAVP). Vasopressin or antidiuretic hormone (ADH) is normally present in the human body, causing the kidneys to concentrate your urine output. The dose of vasopressin you will receive will concentrate your urine to a degree similar to what you experience following a period of limited fluid intake (for example, the urine you pass after a long night's sleep). Because of this effect, you are advised to limit your liquid intake to no more than twelve 8 ounce glasses of liquid in the twenty-four hour period following administration of vasopressin.

We will ask your permission to measure your blood pressure prior to hormonal administration. Following this measurement, you will be asked to practice a computer task. Following the practice trials, you will be asked to inhale a small amount of fluid through your nose and to wait 20 minutes for the hormone to be absorbed. Upon completion of the absorption period, you will again be asked to complete several computer tasks. The total time required for this experiment is two hours.

DDAVP has been known to produce transient headache and nausea in some individuals when administered in high doses, but this is an infrequent effect and the dose used in this study is not high. DDAVP may also produce a slight elevation in blood pressure which is also an infrequent effect. Potential benefits from this study include information regarding the effect of vasopressin on cognitive processes in humans. We hope to obtain results supporting the usefulness of this hormone for improving memory processes in humans. In order to insure unbiased results, you will be assigned to either a treatment group or a placebo group.

All information obtained in connection with this study will remain confidential and will be disclosed only with your permission. Your decision whether or not to participate in this experiment will not prejudice your future relations with UND or the Psychology Department. If you decide to participate, you are free to discontinue participation at any time without prejudice. If you do not wish to participate, you are not required to enter into this research.

The investigators will be available to answer any questions that you may have regarding this study. In addition, you are encouraged to ask questions that occur to you in the future. Questions may be answered by either Robyn Swenson (777-3691) or Dr. Bill Beckwith (777-3451), or Dr. Rolf Paulson (780-6000). In the event of damage or injury resulting from this study, medical treatment will be available as it is to any member of the general public in similar circumstances. Payment for any such treatment must be provided by you or your third party payor. You will be given a copy of this form.

I have read all of the above and willingly agree to participate in this study as explained to me by

_____

_____   _____
Signature   Date

_____   _____
Witness (other than scientist)   Date

APPENDIX D

SOURCE OF VARIANCE TABLES

Table 11

<u>Analysis of Variance Table for Age</u>

SOURCE	SS	DF	MS	F	p
Treatment	5.652	1	5.652	0.101	>0.500
Gender	143.841	1	143.841	2.566	0.114
Treatment X Gender	86.903	1	86.903	1.550	0.217
Unit	4484.109	80	56.051	Not Tested	
Total	4720.500	83	56.873		

Table 12

<u>Analysis of Variance Table for WAIS-R Vocabulary Test (Raw Score)</u>

SOURCE	SS	DF	MS	F	p
Treatment	172.862	1	172.862	0.431	>0.500
Gender	656.942	1	656.942	1.639	0.205
Treatment X Gender	0.159	1	0.159	Very Small	
Unit	31656.773	79	400.719	Not Tested	
Total	32486.730	82	396.180		

Table 13

<u>Analysis of Variance Table for Diastolic Blood Pressure</u>

SOURCE	SS	DF	MS	F	p
Treatment	174.959	1	174.959	0.483	0.490
Gender	795.662	1	795.662	2.197	0.143
Treatment X Gender	17.611	1	17.611	0.049	>0.500
Unit	28612.500	79	362.183	Not Tested	
Total	29600.727	82	360.984		

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Table 14

Analysis of Variance Table for Systolic Blood Pressure

SOURCE	SS	DF	MS	F	p
Treatment	168.358	1	168.358	0.313	>0.500
Gender	17275.113	1	17275.113	32.126	<0.001
Treatment X Gender	12.200	1	12.200	0.023	>0.500
Unit	42480.000	79	537.721	Not Tested	
Total	59935.668	82	730.923		

Table 15

Analysis of Variance Table for Self-reported Weight

SOURCE	SS	DF	MS	F	p
Treatment	248.57	1	248.570	0.087	>0.500
Gender	157840.81	1	157840.813	55.231	<0.001
Treatment X Gender	3544.46	1	3544.456	1.240	0.269
Unit	222909.75	78	2857.817	Not Tested	
Total	384543.56	81	1043.748		

Table 16

Analysis of Variance Table for Day of Menstrual Cycle

SOURCE	SS	DF	MS	F	p
Treatment	11.040	1	11.040	1.138	0.293
Unit	378.231	39	9.698	Not Tested	
Total	389.271	40	9.732		

Table 17

Analysis of Variance Table for Transformed Median Response Times

SOURCE	SS	DF	MS	F	p
Treatment	0.001	1	0.001	0.038	>0.500
Gender	0.009	1	0.009	0.245	>0.500
Treatment X Gender	0.002	1	0.002	0.061	>0.500
Unit	2.855	80	0.036	Not Tested	
Decision	6.269	2	3.134	870.803	<0.001
Treatment X Decision	0.015	2	0.008	2.120	0.124
Gender X Decision	0.004	2	0.002	0.498	>0.500
Treatment X Gender X Decision	0.006	2	0.003	0.861	0.425
Decision X Unit	0.576	160	0.004	Not Tested	
Response	0.110	1	0.110	75.972	<0.001
Treatment X Response	0.002	1	0.002	1.428	0.236
Gender X Response	0.002	1	0.002	1.069	0.305
Treatment X Gender X Response	0.001	1	0.001	0.478	0.492
Response X Unit	0.116	80	0.001	Not Tested	
Decision X Response	0.049	2	0.025	17.242	<0.001
Treatment X Decision X Response	0.003	2	0.001	1.042	0.356
Gender X Decision X Response	0.002	2	0.001	0.706	0.496
Treatment X Gender X Decision X Response	0.000	2	0.000	0.019	>0.500
Decision X Response X Unit	0.229	160	0.001	Not Tested	
Total	10.251	503	0.020		

Table 18

Analysis of Variance Table for Transformed Median Response Time

Controls

SOURCE	SS	DF	MS	F	p
Treatment	0.021	1	0.021	2.409	0.125
Gender	0.024	1	0.024	2.795	0.099
Treatment X Gender	0.002	1	0.002	0.230	>0.500
Unit	0.681	80	0.009	Not Tested	
Response	0.006	1	0.006	9.857	0.003
Treatment X Response	0.004	1	0.004	6.731	0.012
Gender X Response	0.000	1	0.000	0.005	>0.500
Treatment X Gender X Response	0.000	1	0.000	0.011	>0.500
Response X Unit	0.052	80	0.001	Not Tested	
Total	0.790	167	0.005		

Table 19

Analysis of Variance Table for Transformed Difference Scores

SOURCE	SS	DF	MS	F	p
Treatment	0.015	1	0.084	0.221	>0.500
Gender	0.084	1	0.084	1.258	0.266
Treatment X Gender	0.011	1	0.011	0.170	>0.500
Unit	5.357	80	0.067	Not Tested	
Decision	12.559	2	6.280	821.517	<0.001
Treatment X Decision	0.049	2	0.024	3.197	0.044
Gender X Decision	0.016	2	0.008	1.047	0.354
Treatment X Gender X Decision	0.016	2	0.008	1.039	0.357
Decision X Unit	1.223	160	0.008	Not Tested	
Response	0.309	1	0.309	73.906	<0.001
Treatment X Response	0.000	1	0.000	Very Small	
Gender X Response	0.001	1	0.001	0.326	>0.500
Treatment X Gender X Response	0.001	1	0.001	0.241	>0.500
Response X Unit	0.334	80	0.004	Not Tested	
Decision X Response	0.056	2	0.028	8.756	<0.001
Treatment X Decision X Response	0.004	2	0.002	0.569	>0.500
Gender X Decision X Response	0.005	2	0.002	0.744	0.477
Treatment X Gender X Decision X Response	0.000	2	0.000	0.017	>0.500
Decision X Response X Unit	0.509	160	0.003	Not Tested	
Total	20.550	503	0.041		

Table 20

Analysis of Variance Table for Transformed Error Rates

SOURCE	SS	DF	MS	F	p
Treatment	0.000	1	0.000	0.005	>0.500
Gender	0.000	1	0.000	0.007	>0.500
Treatment X Gender	0.281	1	0.281	5.632	0.021
Unit	3.997	80	0.050	Not Tested	
Decision	3.166	2	1.583	68.578	<0.001
Treatment X Decision	0.067	2	0.034	1.452	0.238
Gender X Decision	0.301	2	0.150	6.510	0.002
Treatment X Gender X Decision	0.003	2	0.002	0.067	>0.500
Decision X Unit	3.693	160	0.023	Not Tested	
Response	0.002	1	0.002	0.090	>0.500
Treatment X Response	0.172	1	0.172	7.166	0.010
Gender X Response	0.009	1	0.009	0.384	>0.500
Treatment X Gender X Response	0.016	1	0.016	0.666	0.418
Response X Unit	1.917	80	0.024	Not Tested	
Decision X Response	0.154	2	0.077	3.719	0.027
Treatment X Decision X Response	0.015	2	0.008	0.369	>0.500
Gender X Decision X Response	0.013	2	0.007	0.321	>0.500
Treatment X Gender X Decision X Response	0.089	2	0.045	2.160	0.119
Decision X Response X Unit	3.304	160	0.021	Not Tested	
Total	17.201	503	0.034		

Table 21

Analysis of Variance Table for Transformed Proportion Recall

SOURCE	SS	DF	MS	F	p
Treatment	0.034	1	0.034	1.158	0.286
Gender	0.001	1	0.001	0.029	>0.500
Treatment X Gender	0.037	1	0.037	1.268	0.264
Unit	2.325	79	0.029	Not Tested	
Decision	1.311	2	0.656	39.913	<0.001
Treatment X Decision	0.093	2	0.047	2.839	0.062
Gender X Decision	0.018	2	0.009	0.563	>0.500
Treatment X Gender X Decision	0.037	2	0.019	1.129	0.326
Decision X Unit	2.595	158	0.016	Not Tested	
Response	1.728	1	1.728	100.610	<0.001
Treatment X Response	0.000	1	0.000	0.004	>0.500
Gender X Response	0.000	1	0.000	Very Small	
Treatment X Gender X Response	0.000	1	0.000	0.018	>0.500
Response X Unit	1.357	79	0.017	Not Tested	
Decision X Response	0.086	2	0.043	3.213	0.043
Treatment X Decision X Response	0.050	2	0.025	1.884	0.156
Gender X Decision X Response	0.024	2	0.012	0.895	0.411
Treatment X Gender X Decision X Response	0.002	2	0.001	0.086	>0.500
Decision X Response X Unit	2.102	158	0.013	Not Tested	
Total	11.802	497	0.024		

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