The Influence of Attachment and Stress Reactivity on Young Adults’ Memory Performance

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March, 2010
Purpose of the Research

Research in the field of attachment theory has demonstrated that the quality of the relationship between a child and caregiver has a long developmental impact on the child and influences how they form and behave in subsequent attachment relationships. While much research has focused on the developmental outcomes of early attachment relationships, it has only been more recently that researchers have focused on trying to better understand the specific mechanisms that produce such lifelong effects. In particular, the last decade has seen attachment researchers adopt tools and methods from cognitive psychology to examine whether these early experiences can affect cognition throughout the lifespan. For example, the Stroop task and sequential priming have been used to determine that attachment security is associated with differences in selective attention and unconscious affective biases (Atkinson et al., 2009; Corcoran, Maier, & Waters, submitted). These types of studies are slowly revealing how early experience with caregivers shapes developing cognitive processes, which then in turn affect behaviour in new relationships. The purpose of the current study was to build on these findings and now explore the relationship between attachment security and memory functioning in adolescents and young adults. Given that previous research has shown a link between attachment history, attention, and information processing, it is likely that the quality of a person’s early attachment experiences may affect how they encode and retrieve relationship-relevant memories. Specifically we asked the following questions:
a) Does attachment security affect young adults’ explicit memory (EM) performance for negative attachment vs. neutral stimuli?

b) Does attachment security affect young adults’ implicit memory (IM) performance for negative attachment vs. neutral stimuli?

c) Along with attachment security, what role, if any, does the hypothalamic-pituitary-adrenal (HPA) axis play in memory functioning? Previous research suggests that traumatic attachment experiences (i.e., physical or sexual abuse), as well as current stress, can affect the HPA axis, which in turn can interfere with the hippocampus’s ability to form and retrieve new memories.

*Literature Review and Project Summary*

It was approximately 50 years ago that John Bowlby (1958, 1969/1982) formally introduced the theory of attachment to explain “the nature of the child’s tie to his mother” and the importance of close relationships across the lifespan. At the core of attachment theory is the secure base construct (Waters & Cummings, 2000). Bowlby proposed that optimal human development occurs when an infant can effectively use an attachment figure as a secure base from which to explore and as a haven of safety in times of need. He believed that over time, secure base experiences with the caregiver become internalized into lasting implicit expectations and beliefs about the self, the caregiver, and about how close relationships work. He termed these implicit representations the attachment “internal working model”.

Although Bowlby was quick to borrow these concepts from cognitive psychology, subsequent attachment researchers did little to incorporate cognitive theories and tools into...
their research. It was not until 1985, when Mary Main introduced the Adult Attachment Interview (AAI; Main, Kaplan, & Cassidy, 1985), that attachment researchers had their first tool to investigate a person’s “state of mind with respect to attachment”. More recently, Bretherton (1987, 1990), introduced attachment researchers to the cognitive literature on event schemas and scripts, which in turn has led to the development of new cognitive measures of attachment security (e.g., Waters and Waters, 2006). Other researchers have focused on adapting traditional cognitive tools for better understanding attachment cognitions. Corcoran, Maier, and Waters (submitted), for example, used a sequential priming task in order to assess implicit automatic attachment representations. The main finding from the study was that a person’s attachment history does in fact produce automatic unconscious affective biases towards attachment figures. Those individuals with a secure attachment tended to unconsciously associate their mother with positive and supportive descriptors. People who showed no evidence of having a secure attachment script showed the opposite effect and associated their mother with negative and rejecting descriptors. In another attempt to clarify Bowlby’s IWM concept, Atkinson et al. (2009) used an emotional Stroop task to investigate the relationship between maternal attachment security, selective attention, and infant attachment security. They discovered that a mother’s attachment security was associated with her selective attention as measured in an emotional Stroop task. Mothers classified as having a disorganized attachment reacted slower to negative attachment and emotion words. Furthermore, poor attention processing was associated with her child developing a disorganized attachment at 1 year of age.
One central cognitive system that has yet to receive much attention from attachment researchers is memory. Main et al. (1985) first suggested a link may exist between attachment and memory in adults when they were initially validating the AAI. When creating the interview, one difference they noted was that adults who had sensitive and caring parents remembered more parent-specific memories from their childhood, regardless of whether they were positive or negative. However, adults whose parents showed less affection and were more rejecting in childhood tend to report fewer parent-specific childhood memories. More recently, some researchers have focused on autobiographical memory. Fivush and Vasudeva (2002) found that secure mothers tended to use more elaborative reminiscing styles with their child when asked about past events. Pillemer (1998) suggests that such differences in reminiscing style, partly due to attachment history, will likely lead to differences in the development of autobiographical memory over time. None of this work, however, has focused on basic memory differences that may arise due to a person’s attachment history. Practically nothing is known about how attachment history influences basic memory performance at either the implicit or explicit level. The primary goal of the current study was to investigate whether any such relationship exists.

Attachment relationships are but one factor that is thought to influence memory. A second factor that appears to influence memory, but is itself affected by early attachment experience is the activity of the hypothalamic-pituitary-adrenal axis (HPA). The HPA axis is a neuro-endocrine system in the body that reacts to changes in homeostasis or stress. When activated, the result is the secretion of glucocorticoids into the body. Cortisol (the primary glucocorticoid in humans) interacts with the sympathetic nervous system to mediate a variety
of protective and adaptive processes to stress. While the functioning of the HPA axis is controlled in part by gene expression, researchers have found that early maternal care can affect its development in both humans and animals. Meaney (2001) reviewed the rodent literature and concluded that maternal care can play a large part in the development of the HPA axis. Pups that had received a low amount licking and grooming from their mothers in the first weeks of life had poorer functioning HPA systems. They had chronically higher levels of cortisol in their system, which in turn caused cognitive deficits and made them hypervigilant as adults. Likewise, in humans, despite the short-term protective effect of cortisol, prolonged periods of over-production or poorly regulated cortisol release can have negative effects on psychological wellbeing and cognition. For example, systemic child abuse has been linked with a dampened cortisol response, thought to occur due to a habituation response (Murali & Chen, 2005), which in turn can lead to different mental and physical health problems like depression, chronic fatigue syndrome, and fibromyalgia (e.g., Carpenter et al., 2009). In the cognitive domain, there is also evidence that current HPA reactivity can play a role in memory function. Krischbaum, Wolf, May, Wippich, and Hellhammer (1996) discovered that subjects remembered fewer words from a list if they had first been exposed to a stressful public speaking procedure. This effect appears to occur because high levels of circulating cortisol interfered with the hippocampus’ ability to encode and retrieve new explicit memories.

The overarching goal then of the current study was to build on these findings and explore in more detail the relationship between attachment history, HPA reactivity, and memory performance in adolescents and young adults. Based on the previous literature we
hypothesized that attachment and HPA reactivity could significantly contribute to memory performance for relationship-relevant material. Because of the exploratory nature of this work we did have many specific predictions with regard attachment and EM. We did, however, expect that individuals with the highest cortisol output would do poorer on the EM task due to cortisol’s attenuating influence on the hippocampus. In contrast to the EM predictions, we did believe that attachment representations may produce differences in IM performance. Atkinson et al., (2009) and Corcoran et al. (submitted) found that implicit cognitive biases can vary across attachment types and, therefore, we hypothesized that attachment representations would be related to IM. Specifically, we thought that people with insecure attachment representations would treat negative and neutral implicit stimuli differently and show a bias for negative attachment words. We did not think that cortisol would influence IM performance because IM is not controlled by the hippocampus.

Target Population and Relevant Stakeholders

We chose to study memory performance in an adolescent and young adult population for several reasons. First, it is important to establish that early experience has an enduring impact on later cognitive functioning before studying how this occurs early in childhood and discovering the developmental mechanisms at play. Second, recent work has suggested that attachment schemas and scripts are not fully formed and concretized until late adolescence (Waters & Waters, 2006). Studying such a population gives us the best chance at discovering any links between attachment security and memory.
The findings from this study are meant primarily for attachment, cognition, and psychophysiology researchers. There is a growing push to use traditional cognitive methodologies in order to fill in the details behind Bowlby’s concept of the internal working model and the results from this study should help researchers better understand how attachment experiences are internalized and influence memory development, particularly for relationship-relevant material.

Any clear findings between attachment and memory would also have ramifications for clinicians. If attachment is associated with the EM or IM systems then clinicians would have to take that into account when trying to treat disorganized attachments or other attachment-linked conditions. In addition, clinicians conducting relationship therapy should incorporate any information that links attachment with cognitive biases as this would allow them to better understand why insecure individuals are having relationship problems.

Although not expected, large links between attachment, HPA activity, and EM would be relevant for educators. There is some evidence linking attachment in childhood with general cognitive performance (Jacobsen, Edelstein, & Hofmann, 1994). Strong links between these factors would suggest that educators may have to focus on the family system and stress if they want to improve performance in at-risk individuals.
Methodology

Participants

The sample consisted of 55 undergraduate students (7 males and 48 females) from a large urban university, with 1 participant withdrawing from the study upon arrival. Participants were recruited through the psychology department’s subject pool of introductory psychology students. Recruitment took place through the department’s online signup system and participants were given 2 credits for completing the study. The median age of the sample was 20 years of age. The experiment began between 1 and 3 pm because spontaneous fluctuations in cortisol are lowest in the afternoon. Participants were also asked to refrain from eating, drinking (except water), smoking, and heavy exercise for 1 hour prior to the study start time.

Materials and Procedure

The study began by getting the participant’s informed consent, followed by the first saliva sample, which was taken in order to provide a baseline cortisol value. Each sample consisted of 3 sorbettes that were placed into the mouth, one at a time, and held there for 30-60 seconds or until the swab was saturated with saliva. Salivary cortisol concentrations, were determined by enzyme immunoassay (Salimetrics, State College, Pennsylvania).

The next phase of the study began with participants being exposed to the explicit memory stimuli (see Appendix A). They were told to read two stories and to remember them as best they could as they would be tested for recall at the end of the experiment. One story was a neutral story that described a man being picked up in the morning and going to work. The other
story was an attachment-themed negative story in which a young girl has to stay home sick and is upset because her mother has to leave her alone. Participants were instructed to read through each story twice or until they felt like they had memorized it as best they could. Story presentation order was balanced.

This procedure was followed with a story production task (for examples, see Appendix B). Half the participants started with a story task that was actually the standard attachment script assessment (ASA; Waters & Rodrigues-Doolabh, 2001), a measure of attachment security, and half received a neutral non-attachment story telling task. Each participant received the second type story task later in the visit and story order was counterbalanced. This task was conducted immediately after the baseline cortisol sample because we predicted that it would act as a social stressor and produce a cortisol response in participants. Although this had never been tested before, we based our decision on the previous finding that tasks involving public speaking and evaluation typically produce a human cortisol response (Dickerson, Gruenewald, & Kemeny, 2004). We created a neutral equivalent to the ASA in order to determine whether telling stories in general is enough to provoke an HPA response, or whether there is something special about telling attachment-related stories. The story production task requires an individual to create and tell aloud to the experimenter 4 stories based on prompt outlines that are provided. Each outline contains a title explaining the theme of the story and 12 words arranged to suggest a storyline. Participants are given one outline at a time and asked to use the words to construct a story of approximately one page in length if it were written down. Participants have several minutes to review the outline and when they are ready the story is
told aloud to the experimenter and audiotaped and later transcribed for scoring. In total, the script assessment typically takes approximately 15-20 minutes. The attachment version of the stories consisted of 2 child-parent stories and 2 adult-adult stories and is designed to examine an individual’s knowledge of, and access to, the secure base attachment script. Each story is assigned a score on a 7-point scale based on the quality of the secure base content, with a 7 representing a rich secure base narrative. The participant receives two scores, one for the child-parent stories and one for the adult-adult stories. A score of 3.5 and higher indicates an individual has some knowledge of the secure base script. The neutral version of the story production task included themes about work and recreation and was not scored as it was only included to determine whether it could produce a cortisol reaction.

After the story production procedure participants were instructed to relax for the next 40 minutes in order to assess their HPA response to the stressor and their return to baseline. They were given magazines to read or they could listen to music. They were also instructed to complete a standard demographics form while they waited. Additional saliva samples were taken at 20 and 40 minutes after the end of the story production task.

After the 40 minutes were complete participants began the implicit memory task. This procedure involved exposure to 30 words: 10 negative attachment/emotion words, 10 neutral words, and 10 filler words put at the beginning and end of the lists to offset primacy and recency effects. Each group of negative and neutral words was selected from a larger group of 20 negative and 20 neutral words that were matched for word length and frequency such that 4 pseudo-random lists were generated with words of the same valence never repeating more
than twice (for IM stimuli, see Appendix C). The words from each list were then put on individual cue cards and displayed to the participants for 5 seconds each. Participants were not informed this was a memory task and were simply told to rate each word for pleasantness using a 7-point Likert scale. Participants then completed the second storytelling task which also acted as a distracter.

The memory retrieval phase followed. First, each participant was told to remember back to the beginning of the experiment and to reproduce each explicit story as best they could. As a reminder they were given the title of each story. Participant answers were audiotaped and transcribed and then broken down into their smallest meaningful phrases. Two independent raters then assessed the degree to which their story matched the original, giving one point for each unit recalled. An EM bias score was then calculated by subtracting the score for the neutral story from the score on the negative story, indicating the degree to which an individual remembered the negative story over the neutral story.

Implicit memory was tested next. Each participant was given a list of 40 word stems that displayed the first 3 letters of a word and participants were asked to complete the stem with the first word that came to mind. Each stem had at least two other common answers and our chosen words were never the most common type of word for that stem. These stems represented the original 40 words that were used to create the 4 implicit word lists. This allowed for a performance comparison between the 20 words they had been exposed to earlier and 20 words that were new to them, which would represent their ability to guess words correctly by chance. Each participant received a score for proportion remembered correctly for
studied negative attachment/emotion stimuli, proportion remembered correctly for studied neutral stimuli, proportion correct for unstudied attachment/emotion stimuli, and proportion correct for unstudied neutral stimuli. Bias scores were then generated for each type of stimuli. One bias score was calculated by subtracting the unstudied negative stimuli from the studied negative stimuli. A second bias score was calculated by subtracting the unstudied neutral stimuli from the studied neutral stimuli. Finally an overall bias score was created by subtracting the second bias score from the first, representing the degree to which an individual had a bias in favour of the negative words.

In the final phase of the study participants completed several standard questionnaires. Depression was assessed with the Beck Depression Inventory (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961), a 21-item self-report questionnaire that is one of the most widely used measures of depression. Trait anxiety was measured with the 18-item trait form of the State-Trait Anxiety Inventory (Spielberger, 1983). Finally, child abuse was assessed using the Childhood Experiences of Violence questionnaire (Walsh, MacMillan, Trocme, Jamieson, & Boyle, 2008). This 14-item self-report is a valid but quick technique for assessing abuse experienced in childhood. Individuals are asked when the abuse happened and how often and results are broken down for physical and sexual abuse (e.g., no abuse, moderate, extreme abuse; see Appendix D).

*Study Limitations*

There are several limitations in this study’s design. First, we were using a new technique as a social stressor. Previous research has shown that public speaking and performance based
tasks (e.g., the Trier Social Stress Test) typically produce a cortisol response but we had not explicitly tested the storytelling task prior to this study. One question we wanted to test in this study was whether the story production task could provoke an HPA response and whether this varied by type of stimuli (i.e., attachment vs. neutral stories). To test this, half of the participants received the attachment stories first and half received the neutral stories. The opposite story type was given towards the end of the experiment and was used as a distracter for the IM task.

A second methodological limitation was that we only compared memory performance for negative and neutral stimuli and excluded positive stimuli. This was done in part due to time constraints and in large part because prior research has shown that attachment cognition biases tend to appear when comparing performance on negative and neutral stimuli (e.g., Atkinson et al., 2009). However, this has not been explicitly tested in the memory domain.

Results

Preliminary Analyses

One rater scored all attachment script stories and a second rater scored 25% to establish reliability. As is typically done with the ASA, raters were considered to be in agreement when their scores were within two points of each other. For the child-parent stories raters had 100% agreement and the correlation was .76, \( p < .01 \). Raters were 92% in agreement on the adult-adult stories and their scores were correlated .72, \( p < .01 \).
The recalled EM stories were all scored by one rater and a second independent rater scored 25% of the stories. Raters showed a very high degree of agreement on both the negative ($r = .98$, $p < .01$) and neutral ($r = .97$, $p < .01$) stories.

Our demographic variables were not found to relate to cortisol levels, ASA scores, or implicit and explicit memory scores, and were excluded from further analyses. Saliva samples, which were frozen immediately after each experiment, were thawed and centrifuged. Cortisol concentrations, reflecting the level of unbound cortisol, were determined by enzyme immunoassay (Salimetrics, State College, Pennsylvania). Each participant had 3 samples: baseline, 20 minutes post stressor, and 40 minutes post stressor. In order to produce a normal distribution these values were log-transformed and then plotted. Two values representing total hormonal output, area under the curve ground (AUCg) and area under the curve increase (AUCi) were then calculated.

**HPA Axis Reactivity**

A repeated measures ANOVA was first conducted to determine whether our stressor, the storytelling task, produced a cortisol response and whether this varied depending on task order. Cortisol values at baseline, 20 minutes post-stressor, and 40 minutes post-stressor, were entered as the within-subjects factor and task order was entered as the between-subjects factor. There was a main effect for time ($F[1,48] = 27.93$, $p < .01$) with cortisol values peaking at baseline ($M = .78$, $SD = .30$) and decreasing across the second ($M = 66$, $SD = .28$) and third time points ($M = .57$, $SD = .27$). There was no main effect of task order or interaction ($F$’s less than 1,
indicating that it didn’t matter whether participants completed the attachment stories first or the neutral stories first.

The previous analysis suggests that participants were already showing a stress reaction when they arrived at the lab and the story production task did not produce an additional cortisol response. As such, AUCi was discarded from subsequent analyses because it measures the increase in cortisol after baseline but in this study the majority of participants peaked at baseline. However, because participants’ HPA axis was activated by the study we still felt it useful to examine whether this response was related to the other factors in the study. We first examined the relationship between cortisol output and trait anxiety, depression, and abuse history. Neither AUCg nor cortisol output at any specific time point was correlated with trait anxiety or depression. However, there was a link with a history of physical abuse. A one-way ANOVA with level of abuse (none, moderate, and severe) predicting AUGg was significant, $F(2,38) = 6.11, p < .01$. Tukey’s HSD analysis revealed that the hormonal output for individuals with no history of abuse ($M = 28.37, SD = 10.18$) was similar to those with a moderate abuse history ($M = 24.45, SD = 6.52$) but significantly higher than individuals with a history of severe abuse ($M = 13.77, SD = 7.41, p < .01$). The same relationship did not hold for sexual abuse but this was likely due to the fact that our sample was not at risk and only 3 individuals reported severe sexual abuse.

Links between cortisol output and attachment representations were examined next. The attachment script scores for both the parent-child and adult-adult stories were not significantly correlated with AUCg or with output at a specific time point. To further explore the relationship
between attachment and cortisol, script scores were dichotomized into participants who demonstrated some evidence of script knowledge (i.e., scores greater or equal to 3.5) and those that did not. Cortisol values at the three time points were entered into a repeated measure ANOVA as the within-subjects factor and script score as a between-subjects factor. When using script scores for the adult-adult ASA stories there was a main effect of time ($F[1,44] = 32.28, p < .01$), with cortisol values declining over time, and the main effect for attachment showed a trend ($F[1,44] = 3.56, p = .07$), such that participants with higher script scores showed greater average cortisol output ($M = .71, SD = .34$) than those with low script scores ($M = .57, SD = .35$). The interaction between cortisol and the ASA was non-significant ($F[1,44] = .36, ns$). When the script scores from the child-parent stories was entered as the between-subjects variable the main effect of attachment scores was no longer significant.

Explicit Memory Performance

Performance on the negative and neutral explicit stimuli were significantly correlated, $r = .79, p < .01$. Explicit performance was not correlated with trait anxiety or a history of abuse but performance on the negative story was correlated with scores on the BDI, $r = .32, p < .05$, and the BDI was partialled out of the negative stimuli scores in subsequent analyses.

Attachment representations and EM were also related. The combined scores of the attachment stories were significantly correlated with both negative ($r = .33, p < .05$) and neutral memory retrieval ($r = .37, p < .05$), but not the bias score, which represents the degree to which an individual was biased towards remembering the negative story. A repeated measures ANOVA confirmed a trend between attachment and memory performance. Stimuli type
(negative vs. neutral) was entered as the within-subjects variable and the dichotomized attachment score was entered as a between-subjects variable. There was no main effect for memory stimuli type but the main effect of attachment was a trend, $F(1,48) = 3.5, p = .06$ with secure individuals ($M = 42.62, SD = 24.25$) remembering more units than individuals with low script scores ($M = 34.19, SD = 19.4$). There was no interaction.

Associations between explicit performance and cortisol release were also examined. Total hormonal output, as well as cortisol readings at any specific time point, were not correlated with EM scores. When AUCg was added to the above repeated measures ANOVA it had no significant relationship with EM values, $F(1,48) = .61, ns$.

Finally, links between attachment, cortisol, and EM were examined using multiple regression. The ASA scores and AUCg were entered as predictor variables for the negative attachment story. While the overall model was significant, $F(3,47) = 4.44, p < .05$, only the ASA scores acted as a significant predictor, $\beta = .38, t(1,47) = 2.79, p < .01$. For the neutral story, the same pattern held with only ASA score significantly predicting EM, $\beta = .45, t(1,47) = 3.39, p < .01$.

**Implicit Memory Performance**

Performance for the negative and neutral implicit words were significantly correlated, $r = .48, p < .01$. IM performance was not correlated with trait anxiety, depression, or a history of abuse. IM and EM bias scores were not correlated.
Correlations were first used to examine associations between the ASA and IM. Neither the parent-child nor the adult romantic stories were related to implicit performance on studied words, however, this analysis does not take into account participants’ ability to correctly the word stem even when they had not been previously exposed to the word. In order to unpack any relationship between the ASA and IM, a repeated measures ANOVA was conducted. Stimuli type (negative vs. neutral words) and word exposure (studied vs. unstudied words) were entered as within-subjects variables and the dichotomous adult attachment scores were entered as the between-subjects variable. IM recall was converted into the proportion of word stems correctly entered. This analysis indicated a main effect of stimuli type, $F(1,48) = 7.67, p < .01$, with negative attachment/emotion words ($M = .20, SD = .12$) being recalled more frequently than neutral words ($M = .15, SD = .08$). As predicted, words that participants were exposed to ($M = .24, SD = .12$) were recalled significantly more often than words to which they had not been exposed ($M = .12, SD = .08$), $F(1,48) = 38.32, p < .01$. There was no main effect of ASA score, $F(1,48) = .17, ns$. More importantly, there was a 3-way interaction between the ASA, word stimuli type, and prior exposure, $F(1,48) = 6.32, p < .05$. For words that participants had previously been exposed to, those who showed evidence of having a secure attachment script recalled the negative and the neutral words at the same rate, 26% of the time. The words they had not been exposed to were recalled at similarly low levels, 13% for negative words and 7% for neutral words. Likewise, people with low ASA scores also had low guess rates for the words they had no exposure to, 14% vs. 12%. However, for words they had been previously exposed to, these same individuals recalled the negative words at a higher rate than the neutral words.
(27% vs. 17%), indicating that people without a secure attachment script had some implicit bias for negative attachment/emotion words.

To examine whether HPA axis reactivity played a role in IM performance, AUCg was added to the repeated measures ANOVA as another between-subjects variable. IM performance did not vary depending on hormonal output, $F(1,48) = .21, ns$, and there were no significant interactions between AUCg, ASA scores, and IM performance (i.e., all F's less than 1, $ns$).

Conclusions

Mental representation has always played an important role in attachment theory. Bowlby (1969/1982) believed that early secure base experiences with caregivers become internalized as implicit beliefs and expectations about the self, the other, and how attachment relationships work. It is thought that this IWM plays a significant role in personality development and is instrumental in the formation of new close relationships throughout the lifespan, including parent-child and adult romantic relationships. However, attachment researchers have only recently started to borrowed modern cognitive tools to better understand how the IWM works and interacts with other cognitive and biological systems. The goal of the current study was to expand on this work by investigating how attachment representations are related to stress reactivity and memory performance in adolescents and young adults.
In the first phase of analysis we examined influences on HPA axis activity. The HPA axis is the body's stress coping system and therefore it would not be surprising if it were related to variables like depression and anxiety. Furthermore, links between it and attachment may be expected as the attachment behavioural system is one way in which humans use a close other as a secure base from which to explore their world and as safe haven to return to in times of stress or danger. Therefore we examined links between cortisol output, attachment representations, depression, anxiety, and history of abuse. In this community sample cortisol levels were unrelated to depression and trait anxiety but were linked to abuse history. Those individuals who reported experiencing severe physical abuse had lower levels of cortisol output across all time points as compared with those who had experienced no or only moderate abuse. This finding supports the habituation hypothesis (see Murali & Chen, 2005), which suggests that chronic exposure to stress leads to a dampened cortisol response to new stressors. This also replicated the only other study using the CEVQ along with a laboratory stressor. MacMillan et al. (2009) found that maltreated youth from an at-risk sample also displayed an attenuated cortisol response when exposed to the Trier Social Stressor Test. Our results do not come from an at-risk population but they do show the same pattern, demonstrating that a history of abuse and maltreatment leads to dysregulated functioning of the HPA axis. This is troubling because it means a group that has already experienced extreme hardship and stress can no longer mount a proper physiological reaction in the face of new stress, which in turn is likely lead to further physical and mental health problems.
Perhaps surprisingly, HPA activity and attachment representations were not strongly related. Positive attachment relationships are thought of as protective factors and a key way of dealing with stress. However, we found only a trend existed between total cortisol output and attachment, and only when looking at ASA scores on adult romantic stories. Individuals who showed some evidence of having secure attachment representations tended to mount a larger cortisol response in the face of stress. Rifkin-Graboi (2008) had similar findings although she used a sample of young men and a different measure of attachment. She too found no strong links between attachment security and HPA activity. These results taken together do suggest that HPA axis and attachment systems may be separate and work distinctly in the face of stress. For example, secure individuals may primarily rely on their attachment relationships in the face of stress whereas insecure people, who received unreliable care in childhood, may not be able to use their relationships as a way of dealing with stress and therefore the HPA axis takes on a more prominent role. Regardless, this investigation is one of the first to examine attachment and cortisol activity in response to a stressor in this age group and so no firm conclusions can be made from these results.

Explicit Memory Findings

Based on previous research we hypothesized that attachment, but particularly HPA functioning, would be related to EM performance. There was limited support for this hypothesis. First, there was no evidence of a relationship between cortisol output and EM. This is somewhat surprising as previous research has shown that high levels of cortisol can impair the hippocampus and affect the ability to learn new information (Newcomer, Craft, Hershey,
Askins, & Bardgett, 1994; Kirschbaum, Wolf, May, Wippich, & Hellhammer, 1996). One explanation may be that most participants in this study were showing some stress upon arrival at the lab and their cortisol levels declined over time rather than increasing after our stressor. As such, their cortisol levels may not have been high enough to interfere with memorization during the EM task.

Our results also provided little evidence that attachment representations influence EM performance. There was a statistical trend where individuals with higher ASA scores tended to remember more pieces of information from both the negative and neutral stories. Attachment scores were not related to the EM bias score, which means that attachment was not related to improved memory performance for a particular type of story. This result was not expected. Given the evidence that secure individuals tend to be more open to accessing and discussing negative emotions we hypothesized that, if any effect was to emerge, secure individuals would be better than insecures at remembering information from the negative relationship story. While previous research suggests that memory biases could arise due to an individual’s attachment history, it is difficult to understand why a relational behavioural system could affect EM in general. However, there are a handful of findings linking attachment to cognitive performance in children (e.g., Jacobsen, Edelstein, & Hofmann, 1994). These findings are very preliminary and need to be supported by additional research. To our knowledge no other developmental attachment researchers have published work examining attachment representations and EM in this age group. Furthermore, this study used full stories to examine EM, whereas it is much more common to use word lists which are more amenable to
experimental control. Future studies need to use multiple methods of examining EM in order to determine whether links between attachment and EM actually exist.

Implicit Memory Performance

In contrast to EM performance, we hypothesized that HPA reactivity would not be related to IM because it does not involve the hippocampus. This hypothesis was supported as no link was found between these variables.

Previous research, however, has shown that insecure attachment representations are related to negative unconscious biases (Corcoran et al., submitted) and so we hypothesized that people who scored low on the ASA may treat negative and neutral stimuli differently. Secure individuals are able to deal openly with positive and negative emotions and so we did not expect them to respond differently to the stimuli. This hypothesis was supported. Secure individuals in this study remembered neutral and negative attachment words at the same rate whereas individuals who scored low on the ASA recalled negative words at a significantly higher rate than neutral words. This indicates that these latter individuals are unconsciously attending to and storing negative information. Again, this finding is very preliminary and replication is needed. However, it does suggest that a history of poor attachments may produce a systemic implicit memory bias for negative information. This would affect how these individuals interpret and think about past situations, which could then affect how they respond in future attachment situations and relationships. Unconsciously, they may tend to pick up on and recall mainly the negative aspects of their relationships, making it very difficult to ever formulate new, secure attachments or to act securely for their own children.
Recommendations and Next Steps

As previously mentioned these findings are very preliminary and require replication using improved methodologies. In this study we were unable to provoke a cortisol response using the ASA so future work should use a standard stressor like the Trier Social Stressor Test instead. In addition, because our participants’ cortisol levels were already higher than resting levels when they arrived at the lab, it would be useful to start the study with something that isn’t stressful so that their HPA system could return to baseline before the true stressor was started. This would lead to more accurate HPA readings.

Improvements could also be made to the memory assessments. Due to time limitations and because some previous research has shown that secure and insecure individuals tend to respond similarly to positive stimuli (e.g., Atkinson et al., 2009), we only included negative and neutral stimuli in this study. Future research should confirm whether there are any differences for positive stimuli. In addition, other standard assessments of EM, such as word lists, should be used to establish whether attachment and cortisol play a role in memory performance.

If the findings from this study can be replicated it would suggest that an individual’s attachment history, and the IWM that forms from these experiences, have an important influence on other cognitive systems such as memory. This would confirm Bowlby’s hypothesis that the IWM forms early in childhood and lasts into adolescence and adulthood, providing a framework for interpreting and responding to incoming attachment information and responding in kind. Future research should focus on when and how these biases develop in childhood and what mechanisms are responsible. One lead comes from Fivush and Vasudeva
(2002), who demonstrated that mothers of secure children tend to have more elaborate reminiscing styles. Researchers will also need to establish whether this bias affects the way memories are encoded or whether it acts at the retrieval stage when a person is trying to recall something.

These findings are also of relevance to clinicians. At-risk populations could be identified and selected for interventions that target these mechanisms so that there is less likelihood of negative relationship biases forming. This would also be of relevance in for couples counselling as correcting implicit biases would be of paramount importance for improving behaviour.

Finally, this study demonstrated a very weak association between attachment and EM. Future research needs to determine the degree to which this link exists, if at all, and how it develops. If a sizeable enough link is established it would have ramifications for our education system and how we think about learning within the greater context of the family.

Knowledge Exchange Plan

The primary method of knowledge exchange for this study will be through traditional academic channels. We feel that this is the most appropriate course given that these results are preliminary and need further replication before firm conclusions can be made, particularly with respect to EM.

Since data collection took longer than planned, data analysis was not completed until recently and formal knowledge exchange activities have yet to begin. At this point results have only been presented and discussed amongst researchers and graduate students affiliated with
our lab. One planned avenue of exchange is within the local academic community. For example, we hope to present these results to the Ryerson Psychology Department in a future colloquium if scheduling permits. Local attachment researchers from Ontario and Quebec also hold a yearly workshop and we plan to submit these results for discussion. Our lab also plans to present some of our results to Toronto Early Years Centres staff. We recruited subjects from these centres for a separate major project that I participated in that looked at associations between attachment, maternal sensitivity, heredity, and the development of infants’ stress response. In turn we would like to give back to this community by informing staff of the results of from our studies. We have been in contact with these Centres and hope to present our results within the next 6 months.

A second major exchange route will be through more traditional academic outlets. One outlet will be to compile and submit these results to the next biennial conference of the Society for Research in Child Development, the largest child development conference in North America. We also plan to submit these results for publication in academic journals and we believe there are two potential submissions. One will be a short paper detailing the association between the CEVQ and a dampened cortisol response and will be submitted to a psychophysiology journal. This finding is important because it provides further validity data for the CEVQ, which is a relatively new measure of self-reported abuse. It also bolsters other research that has shown a link between early maltreatment and a dampened cortisol response. There is still some controversy in the field regarding this phenomenon and our results will provide more evidence on this point. The second article we plan to write will outline the link between attachment
representations and memory performance. This will be one of the first articles linking attachment and memory and we plan to submit this to a major child development journal or an attachment journal.
References


Appendix A: Explicit Memory Stimuli

Story #1 – Another Day at the Office

Sam locked his front door and walked out to the curb to wait for his carpool. It was another cold morning but at least the sun was out today. A few seconds later the familiar blue van drove up. Sam threw open the van door and climbed in. “Hey Sam, you awake?” asked Jim, the driver of the carpool. “ Barely,” replied Sam, “I was up late watching the game.” “Yeah, I saw this morning that they ended up tied. How strange is that? Well at least they are still in the playoff hunt. Oh, and I brought you a coffee to wake you up,” said Jim and he handed over a nice warm travel mug. “Thanks a lot Jim, this is just what I need on a cold morning like this. I’ll pick up the gas on the way home today. Anyway, the game was okay, just wish someone would have won. I think I might try to get some tickets for next week’s game.” “Well let me know if you have some extras, I’d love to take my boys” said Jim. “Sure, I’ll see what I can do. Tickets are getting hard to find nowadays but I have a friend who works for a big ad agency and they often have some floating around,” responded Sam. “Ok, let me know what you find out,” said Jim.

The rest of the ride was mainly quiet. Jim dropped Sam off right on time and said goodbye. “Thanks again for the coffee, I’ll see you tonight,” waved Sam. He walked inside, sat down at his desk, and turned on his computer. While he finished his coffee, he browsed his favourite internet sites. He checked the news but it was a slow news day. He then checked the weather for the rest of the week and saw that it was going to remain cold. A travel ad at the top of the page caught his eye. A deal for two to go skiing out in BC. Something he’d always wanted
to do but never had the time for. He emailed the link to himself and thought he’d run it by his wife tonight. Now it was time to get down to work.

Sam turned his attention to the latest diagrams he had been working on, but before he could get started he realized he needed to talk with his co-worker. “Hey Linda, how are things?” he said as he knocked on her door. “Hey Sam, I’m good, how are you?” she replied. “Oh, same old I guess. I was just wondering if you had had a chance to finish up your part of the design yet?” he asked. “I’m almost done. I was able to complete almost everything last night. I just need to finish up a few details and then I will email everything to you so you can look it over. Let me know what you think and I’ll make any changes you need,” Linda replied. “Thanks, I appreciate it. I’d like to finish everything up by the end of this week and then we can submit it to management. Anything else new and exciting going on?” he inquired. “Oh, not too much. Too cold to do anything exciting right now. Oh, but did you remember we are all going out to that new restaurant tonight after work?” “Oh yeah, I did forget actually. I have a lot to do today but I think I can get everything done in time and join you guys later. I’m pretty tired though so I won’t make any promises,” he replied. “Yeah, no worries” said Linda, “it’s been a long week so I understand.” “Ok, I guess that means I should get back to work so we can get out of here,” Sam stated. “Maybe I’ll see if my wife wants to join us too,” and he walked back to his office.
Anne punched out her mother’s number frantically. “Hi Mom,” she said on receiving an answer. “Could you possibly look after Missy today? She’s sick. Allan flew to Indianapolis on business last night and I’ve got to have the Hays account finished by the end of the week.” “What’s wrong with Missy?” Anne’s mother Lucille asked. “I don’t know exactly. She has a stomach ache and says that her skin is tingly all over. Her head feels hot. Maybe she has a fever, I don’t know,” Anne responded. “Can you come over?” “I don’t know if I can come today,” Anne’s mother replied. “I’ve got Betty and Tina coming over for lunch. You remember Betty don’t you? She’s the one who rented the houseboat at an awful price and travelled up the Rhine last summer.” The older woman paused. “Why don’t you call a babysitter?” “Because I’d hoped that you would be able to be with her. You know how she complains about babysitters,” her daughter pleaded. “Well” said Anne’s mother, “how about I come over after my lunch? Missy will be fine by herself for the morning. She’ll just watch TV or sleep and I can call her every once in a while.”

Meanwhile, Missy was lying in her bed and could hear her mother speaking to her Grandma. She felt feverish and whiny. “Why can’t YOU stay home with me Mummy? I don’t feel good.” “You don’t feel WELL dear,” her mother replied. “I can’t stay home and that’s that. It’s not my fault you decided to get sick this week.” Anne wasn’t sure what to do. She worried that Missy was too young to stay home alone, but she had a meeting to get to so she agreed. “Thanks Mum,” she said. “I’ll tell Missy to expect you after lunch.” Anne felt like telling her she was angry that her mother wouldn’t look after Missy all day but decided she’d better not start a
fight or her mother wouldn’t come at all. “Now you behave yourself this morning, young lady,” Anne told Missy, “and if you have any problems, you call your grandma okay? I’m sure you’ll be fine though.” After her mother closed the door Missy started crying. “Mummy!” she yelled as her mother walked away. “Can I have some Neocitran?” But it was too late; her mother didn’t hear her.

Missy felt abandoned. She was too tired and felt too sick to go to the kitchen to get a drink and she had already finished the glass of water that her mother had brought her earlier. Her bones ached and she looked at the pictures of lonely puppies on her wall and felt sad. She hoped that she wouldn’t throw up in her room but she fetched the wastepaper basket just in case. She knew her mother thought she was pretending to be sick but she really did feel terrible. She turned the TV on, propped some pillows beneath her head, and tried to watch the news. There was a story about a car crash where the whole family except for the father was killed. She switched to another channel and watched an ad for a dishwashing liquid. Then she watched a superman cartoon. Soon she fell asleep with the TV on. When she woke up she felt even more tired and thirsty and even a bit hungry. It was afternoon already. “Grandma!” she yelled out but there was no answer; her grandmother was not there. Missy phoned her grandmother and asked her when she was coming. “I’ll be there soon dear,” she said, “as soon as I can say goodbye to my friends.” “I’m thirsty Grandma and I feel sick” she said. “Nobody loves me,” the girl thought to herself and started crying. “I’ll be there in a few minutes Missy, stop that crying,” her grandmother replied and hung up.
Appendix B: Story Production Task Examples

Parent-Child Attachment Story: Baby’s Morning

mother       hug       teddy bear
baby         smile     lost
play          story     found
blanket      pretend     nap

Adult-Adult Attachment Story: Jane and Bob’s Camping Trip

Jane         tent       campfire
Bob          wind       shadow
bags         collapse       sounds
hurry       upset       hug
### Appendix C: Implicit Memory Stimuli

<table>
<thead>
<tr>
<th>Negative Condition (freq)</th>
<th>Matching Neutral Condition</th>
<th>Fillers</th>
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</thead>
<tbody>
<tr>
<td>1. SUFFER (33 V)</td>
<td>BRANCH</td>
<td>PROBLEM</td>
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<tr>
<td>2. BETRAY (4 V)</td>
<td>CURTAIL</td>
<td>CONTAIN</td>
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<tr>
<td>3. GRIEF (10 N)</td>
<td>FOLLY</td>
<td>BREAK</td>
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<td>4. LONELY (25 J)</td>
<td>SUBTLE</td>
<td>CARTOON</td>
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<td>5. NEGLECT (12 V)</td>
<td>HARVEST</td>
<td>LEMON</td>
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<tr>
<td>6. REGRET (9 N)</td>
<td>RETIRE</td>
<td>TOASTY</td>
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<tr>
<td>7. INSENSITIVE (3 J)</td>
<td>INVOLUNTARY</td>
<td>MANAGE</td>
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<tr>
<td>8. DISTRESS (15 N)</td>
<td>EMPLOYER</td>
<td>DELIVER</td>
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<td>9. FORSAKEN (2 V)</td>
<td>ACTIVATE</td>
<td>KNIGHT</td>
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<tr>
<td>10. UPSET (14 J)</td>
<td>BLANK</td>
<td>SALAD</td>
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<tr>
<td>11. DEPRESSED (11 J)</td>
<td>INCAPABLE</td>
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<td>12. CRUEL (15 J)</td>
<td>SHEER</td>
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<td>13. JEALOUS (4 J)</td>
<td>PUNGENT</td>
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<td>14. MISERY (15 N)</td>
<td>ANCHOR</td>
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<tr>
<td>15. ANGER (48 N)</td>
<td>PLAIN</td>
<td></td>
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<tr>
<td>16. SHAME (21 NV)</td>
<td>CRACK</td>
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<td>17. WITHDRAWN (4 V)</td>
<td>TELESCOPE</td>
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<td>18. SORROW (9 N)</td>
<td>DOMAIN</td>
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<tr>
<td>19. BLEAK (10 J)</td>
<td>LUNAR</td>
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<tr>
<td>20. DESPAIR (21 N/V)</td>
<td>SUMMARY</td>
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Trait form of State-Trait Anxiety Inventory:

Your responses will be treated completely confidentially, and results will only be referred to in statistical form or anonymously. Please read the following statements about how people feel in general. Circle the number that best describes how you generally feel. There are no right or wrong answers.

1. I feel pleasant
   Almost never 1 2 3 4 5 6 7 Almost always

2. I feel nervous and restless
   Almost never 1 2 3 4 5 6 7 Almost always

3. I feel satisfied with myself
   Almost never 1 2 3 4 5 6 7 Almost always

4. I wish I could be as happy as others seem to be
   Almost never 1 2 3 4 5 6 7 Almost always

5. I feel rested
   Almost never 1 2 3 4 5 6 7 Almost always

6. I am ‘calm, cool and collected’
   Almost never 1 2 3 4 5 6 7 Almost always

7. I feel that difficulties are piling up so that I cannot overcome them
   Almost never 1 2 3 4 5 6 7 Almost always

8. I worry too much over something that doesn’t really matter
   Almost never 1 2 3 4 5 6 7 Almost always

9. I am happy
   Almost never 1 2 3 4 5 6 7 Almost always

10. I have disturbing thoughts
    Almost never 1 2 3 4 5 6 7 Almost always

11. I lack self-confidence
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<th>Question</th>
<th>1</th>
<th>2</th>
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<td>13 I make decisions easily</td>
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<td>14 I feel inadequate</td>
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<td>15 I am content</td>
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<td>16 Unimportant thoughts run through my mind and bother me</td>
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<td>17 I take disappointments to heart and I can’t put them out of my mind</td>
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<td>18 I get in a state of tension or turmoil when I think about my recent</td>
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<td>concerns and interests</td>
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Childhood Experiences of Violence Questionnaire

We would like to ask you some questions about bad things that happen to some children. All of your answers will be kept private.

1. Sometimes kids get hassled or picked on by other kids who say hurtful or mean things to them. How many times did this happen to you before age 16?

☐ Never → go to Question 3
☐ 1 or 2 times
☐ 3 to 5 times
☐ 6 to 10 times
☐ More than 10 times

2. When did this happen? MARK ALL THAT APPLY.

☐ Before you began grade school?
☐ While you were in grade school?
☐ While you were in high school?

3. Sometimes kids get pushed around, hit or beaten up by other kids or a group of kids. How many times did this happen to you before age 16?

☐ Never → go to Question 5
☐ 1 or 2 times
☐ 3 to 5 times
☐ 6 to 10 times
☐ More than 10 times

4. When did this happen? MARK ALL THAT APPLY.

☐ Before you began grade school?
☐ While you were in grade school?
☐ While you were in high school?

5. How many times before age 16 did an adult spank you with their hand on your bottom (bum), or slap you on your hand?

☐ Never → go to Question 7
☐ 1 or 2 times
☐ 3 to 5 times
6. When did this happen? MARK ALL THAT APPLY.

☐ 6 to 10 times
☐ More than 10 times

7. How many times before age 16 did an adult slap you on the face, head or ears or hit or spank you with something like a belt, wooden spoon or something hard?

☐ Never → go to Question 9
☐ 1 or 2 times
☐ 3 to 5 times
☐ 6 to 10 times
☐ More than 10 times

8. When did this happen? MARK ALL THAT APPLY.

☐ Before you began grade school?
☐ While you were in grade school?
☐ While you were in high school?

9. Before age 16 did an adult push, grab, shove or throw something at you to hurt you?

☐ Never → go to Question 11
☐ 1 or 2 times
☐ 3 to 5 times
☐ 6 to 10 times
☐ More than 10 times

10. When did this happen? MARK ALL THAT APPLY.

☐ Before you began grade school?
☐ While you were in grade school?
☐ While you were in high school?

11. Before age 16 how many times did an adult kick, bite, punch, choke, burn you, or physically attack you in some way?
12. When did this happen? MARK ALL THAT APPLY.

☐ Never ➔ go to Question 13
☐ 1 or 2 times
☐ 3 to 5 times
☐ 6 to 10 times
☐ More than 10 times

13. Before age 16 when you were growing up, did anyone ever do any of the following things when you didn’t want them to: touch the private parts of your body or make you touch their private parts, threaten or try to have sex with you or sexually force themselves on you?

☐ Never ➔ Finished!
☐ 1 or 2 times
☐ 3 to 5 times
☐ 6 to 10 times
☐ More than 10 times

14. When did this happen? MARK ALL THAT APPLY.

☐ Before you began grade school?
☐ While you were in grade school?
☐ While you were in high school?