The Role of the Amygdala in Subjective Experiences of Anger and Fear

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Abstract

The role of the amygdala in the processing of subjective basic emotions is still debated in neuropsychological research. The question of whether amygdala lesions result in a decrease of intensity of all affective states, or whether this decrease is limited to anger and fear, remains unanswered due to inconsistent findings from empirical studies. Past studies have tended to focus on individuals with either a healthy or damaged amygdala. The current study, however, has taken a new approach by comparing the retrospective descriptions of subjective emotional experiences of individuals before and after amygdala damage, and between these individuals and participants with a healthy amygdala. Patients suffering from Urbach-Wiethe Disease (UWD) lose their amygdala by puberty as a natural consequence of the disease. Eight UWD and eight matched control group participants, aged 23 to 69, were interviewed, using semi-structured interviews, and asked specific questions about past and current emotional experiences in their lives. Participants were matched on age, race, gender, socio-economic status, home language, level of education, and geographical location. As predicted, the subjective experience of anger and fear as dominant emotions in a population with damage to the amygdala was lower when compared to the controls. Furthermore, UWD participants, but not controls, experienced anger and fear with less intensity in adulthood when compared to childhood. The implications of amygdala damage on subjective emotional experiences are discussed.

Keywords: basic emotions; amygdala; anger; fear; Urbach-Wiethe disease; neurobiology

The notion that the amygdala is associated with the processing of affective states is not new. However, subjective internal experiences, whether experienced by animals or humans, are difficult to study empirically. Animal studies have demonstrated precise roles for the amygdala in processing specific aspects of negative emotional states, but as animals are unable to describe or report their subjective emotional experiences, these studies have been indirect and based on empirically-guided theoretical inferences from affective behaviour (Panksepp, 1998). Although functional imaging studies (fMRI) of humans have provided convincing evidence of a correlation between the activation of the amygdala and specific basic emotional behaviours, direct measures with which changes in subjective emotional experiences can be unambiguously quantified have yet to be developed.

The amygdaloid complex is one of the brain structures most often associated with the processing of affect. More specifically, neuroscientific findings have proposed that a healthy, functioning amygdala plays a critical role in processing two of the basic affective states, namely anger and fear (Adolphs, 2003; Adolphs & Spezio, 2006; Davis & Whalen, 2001; Emery et al., 2001; Izard, 2007; Maren, 2001; LeDoux, 2003; Panksepp, 1998, 2005, in press; Phelps, 2006; Schmolck & Squire, 2001; Vuilleumier, 2005; Whalen et al., 2001). These studies have suggested that amygdala lesions in humans can result in impairments of emotion perception, such as incorrect evaluation of angry and fearful facial expressions, as well as impaired conditioned fear responses. Inferences drawn from these studies suggest that damage to the amygdala alters an individual's subjective experience of negative emotions, by decreasing the intensity of the experience of anger and fear.

In contrast, other studies reported that the amygdala plays a role in the processing of all emotions, and is activated during aversive as well as pleasant stimuli (Anderson et al., 2003; Davis & Whalen, 2001; Hamann, Ely, Hoffman, & Kilts, 2002; Kim & Hamann, 2007; Yang et al., 2002). These studies suggested that amygdala damage alters the emotional life of an individual as a whole. Anderson and Phelps (2002) argued that the amygdala is not critical to the processing of affective states and concluded that individuals with either unilateral or bilateral amygdala damage do not experience emotions differently to those of normal, healthy individuals.

Although evidence from human neuroimaging studies suggested that the amygdala is involved in the processing of negative emotions, few studies have directly investigated the subjective emotional experiences of individuals with selective bilateral amygdala damage. More specifically, few past studies have analysed the changes of subjective emotional

experiences of individuals before and after amygdala damage as described retrospectively by the individuals themselves.

Patients with selective bilateral amygdala damage provide a unique sample for the study of changes in the subjective emotional experiences associated with the amygdala. The amygdala calcifies by puberty as a natural consequence in individuals diagnosed with Urbach-Wiethe Disease (UWD) (Staut & Naidich, 1998; Thornton et al., 2008; Van-Hougenhoucktulleken et al., 2004). The disease results in selective bilateral amygdala calcification, without affecting other brain regions. These cases resemble animal studies of bilateral amygdalectomy, with the important difference that UWD patients have the ability to verbalise their subjective emotional experiences and describe how their affective states have changed between childhood and adulthood. By investigating these changes, we can better understand the role the amygdala plays in processing subjective affective states, specifically the emotions of anger and fear, and how loss of this significant component of neuronal networks affects an individual's subjective emotional experiences.

This research explored the subjective affective states and the intensity of emotional experiences of both UWD individuals and a matched control group. Specific emphasis was placed on analysing the subjective experiences of anger and fear, and comparing these to the subjective experiences of other emotions, specifically sadness and happiness. Semi-structured interviews were conducted with the participants, after which descriptive and inferential statistics were employed to compare the prevalence and emotional intensity of these basic affective states experienced by UWD individuals in childhood and in adulthood. Furthermore, the prevalence and emotional intensity of these basic affective states in childhood and adulthood were compared between the UWD participants and the healthy controls.

Background

It is widely accepted that the internal experience of basic emotions arises from neurobiological events. Past studies have specified a variety of brain mechanisms that are essential to processing basic affective states. More specifically, affective neuroscientific studies have identified the amygdala as an important brain structure for processing basic emotions, particularly the basic emotions of anger and fear (Dalgleish, 2004; Panksepp, 1998, in press; Phelps et al., 2008).

Basic Human Emotions

Although there are contrasting views on the definition of basic emotions (for a review, see Barrett et al., 2007), this dissertation is grounded in Ekman's approach, which proposed that each basic emotion has unique characteristics that are products of evolution and distinguish basic emotions from other affective phenomena (Ekman, 1992). According to Ekman (1999), there are six basic emotions, namely happiness, sadness, anger, fear, disgust and surprise. Happiness is evoked by feelings of well-being, contentment, and joy. Sadness has been associated with feelings of loss, helplessness, sorrow, and despair. Anger is evoked by a perceived provocation and threat, while fear is evoked by perceived threat and pain, and has been associated with behaviours of escape and avoidance. Ekman (1973) based his theory of basic emotions on the compelling evidence provided by research of unique facial expressions that clearly distinguished basic emotions such as anger, fear, happiness, and sadness from one another.

For decades, neuroscientists have studied emotional states in animals, in the hope of finding specific neural substrates of basic emotions in the animal brain that would provide a deeper scientific understanding of basic human emotions (Ekman, 1973). More recently, human fMRI studies have provided convincing evidence of a correlation between the activation of neuroanatomical structures and specific basic emotions. Taken together, evidence from past research has shown that basic emotions emerge from active processes in specific subcortical circuits that are homologous in all mammals (Panksepp, 1998).

Previous research has indicated that anger is generated in the rage system circuit that begins in medial areas of the amygdala, runs through discrete areas of the hypothalamus, and projects into the dorsal periaqueductal grey (PAG) of the midbrain (Nell, 2006; Panksepp, 1998; Solms & Turnbull, 2002). Similarly, fear is generated in the fear system that runs from the lateral and central nuclei of the amygdaloid complex to the medial and anterior hypothalamus, and ends in the dorsally situated areas of the PAG of the brainstem (Panksepp, in press; Shin & Handwerger, 2009; Solms & Turnbull, 2002). These findings suggested that the amygdala plays an important role in processing anger and fear. Other basic emotions, such as sadness (previously found to be generated in circuits that end in the anterior cingulate cortex) and happiness (previously found to be generated in circuits originating in the ventral tegmental and non-specific thalamic reticular nuclei areas) do not seem to be dependent on amygdala activation (Panksepp, 1998).

Anatomy and Function of the Amygdala

The amygdala, located in the ventro-medial anterior part of the temporal lobes, is an almond-shaped structure made up of subcortical neurons. It is a complex collection of 13 nuclei (Adolphs, 2010), each of which has distinct functional traits. The lateral, basal, and accessory basal nuclei make up the basolateral amygdala, which, together with the surrounding structures of the central, medial, and cortical nuclei, complete the amygdaloid complex, abbreviated simply as the amygdala (Davis & Whalen, 2001).

Studies dating back to Kluver and Bucy (1939) established that the amygdala plays an important role in regulating emotional behaviour. Weiskrantz (1956) conducted the first experimental studies on monkeys that directly correlated the amygdala with emotions. Since then, numerous studies have found that damage to the amygdala results in an impairment of the ability to evaluate emotional and social meanings of visual stimuli, especially facial expressions, and in processing and regulating negative emotions in response to threatening stimuli (Adolphs, 2003; Adolphs & Spezio, 2006; Anderson, Spencer, Fulbright, & Phelps, 2000; Davis & Whalen, 2001; Dillon, Deveney, & Pizzagalli, 2011; Tranel, Gullickson, Koch, & Adolphs, 2006; Vuilleumier, 2005).

Previous studies of a single patient with focal bilateral amygdala damage, known as patient SM, provided compelling evidence for the role of the amygdala in the processing of emotional stimuli. SM was unable to recognise fear in facial expressions, and did not experience normal reactions of fear when shown fear evoking movie clips (Tranel, Gullickson, et al., 2006). According to Tranel et al. (2006), SM did not experience deep negative emotions, and in particular lacked feelings of anger and fear.

Numerous studies have found that the amygdala is activated by fear-evoking stimuli, rather than stimuli evoking other types of emotion, such as anger, sadness, or happiness (Irwin et al., 1996; Morris et al., 1996; Phillips & Young, 1997). More recent studies have suggested that the amygdala also plays a critical role in the processing of negative emotions other than fear, such as anger and sadness (Adolphs & Tranel, 2004; Drevets, 2003). A number of fMRI studies have suggested that the amygdala does play a role in the processing of some positive emotions, as it is activated during both aversive and pleasant stimuli (Anderson et al., 2003; Davis & Whalen, 2001; Hamann et al., 2002; Kim & Hamann, 2007; Yang et al., 2002).

However, other studies have found evidence that is inconsistent with fMRI evidence suggesting that the human amygdala is important for the processing of subjective experience of basic emotions (Siebert, Markowitsch, & Bartel, 2003). The divergent research findings

may be due to different methodologies and differing aetiologies of amygdaloid damage used between the studies (Hamann et al., 2002).

Research has further revealed that fear cannot be conditioned in animals that have suffered damage to the amygdala (Davis, 1992; Fanselow, 1994; LeDoux, 1992, 2003; Maren, 2001; Wilensky, Schafe, Kristensen, & Le Doux, 2006). The significance of the amygdala in human beings has been studied mainly using fMRI scans, which have consistently shown changes in activity within the amygdala, especially increased blood oxygenation levels, during fear conditioning (LaBar, Gatenby, Gore, LeDoux, & Phelps, 1998). Similar studies have found increased blood oxygenation level-dependent signals in the amygdala in response to an anger stimulus (Whalen et al., 2001).

The controversies regarding the role of the amygdala in the processing of basic affective states, and the ongoing debate around which basic emotions the amygdala is critical for, persist. The study of the emotional functions of the amygdala faces special difficulties, mainly due to the fact that naturally occurring bilateral, complete amygdala lesions are exceedingly rare, and when present, they frequently involve many other structures in addition to the amygdala. Neuroscientific studies of individuals whose amygdala has been selectively damaged could potentially provide a unique opportunity for the study of subjective affective states in humans. One such disease is Urbach-Wiethe Disease, which results in more-or-less pure bilateral amygdala calcification.

Urbach-Wiethe Disease

Urbach-Wiethe Disease (UWD), otherwise called Lipoid Proteinosis or *Hyalinosis cutis et mucosae*, is a rare hereditary disorder that has been traced to northern European descent (Emsley & Paster, 1985). DNA studies of patients diagnosed with UWD have identified the ECM1 gene as the mutated gene responsible for inheriting this autosomal recessive trait (Hamada et al., 2002, 2003).

Lipoid Proteinosis (LP) was originally defined as a dermatological condition, which resulted in a deposition of a lipid-glycoprotein complex (i.e., hyalin material) in the mucous membranes of the upper digestive system and the skin of the face and joint areas (Urbach & Wiethe, 1929). Patients diagnosed with LP suffer from nodular dermatosis from an early age. Other symptoms, such as hoarseness and an inability to cry, are apparent from birth, although there is clinical variability amongst the patients, ranging from mild to severe clinical manifestations (Nanda, Alsaleh, Al-Sabah, Ali, & Anim, 2001; Scott & Findlay, 1960; Van-Hougenhoucktulleken et al., 2004). Subsequent to the original dermatologically centred

studies, neuroscientific research established a widespread multisystem involvement in this disease. Intracranial calcifications were demonstrated in x-rays of the skull, and CT scans and post-mortem studies established that approximately 50% to 75% of LP patients developed bilateral, symmetrical calcification of the anteromedial temporal lobes, especially in the amygdala, by the time they reached puberty (Newton, Rosenberg, Lampert, & O'Brien, 1971; Staut & Naidich, 1998; Thornton et al., 2008; Van-Hougenhoucktulleken et al., 2004).

Approximately 300 cases of patients suffering from UWD have been reported in literature worldwide since Urbach and Wiethe first defined the disease (Aroni, Lazaris, Papadimitriou, Paraskevakou, & Davaris, 1998; Cote, 1998), and of those, approximately 60 individuals live in the Namaqualand area of the Northern Cape province of South Africa.

Previous studies on patients with UWD have provided insight into the role of the amygdala in facial recognition of negative emotions (Adolphs, 1999; Adolphs, Damasio, & Tranel, 1996; Calder et al., 1996; Thornton et al., 2008). The UWD participants in these studies showed impairments in the ability to recognise fearful and other negative facial expressions, while showing no impairment in the recognition of happy expressions. However, Siebert et al. (2003), who studied 10 UWD patients, found that the patients did not show any impairment in recognition of the basic emotions of anger and fear. The variation across the studies may be due to the small sample sizes and differing methods of assessing symptomatology of the disease. Most studies have reported that UWD patients show impairment of recognition of anger and fear, and the dominating neuroscientific view is that bilateral amygdala damage underlies this impairment.

A recent study of a patient diagnosed with UWD found that the patient had serious impairments with recollection of autobiographic episodes, while his ability to remember and recall autobiographical facts remained intact (Wiest & Brainin, 2010; Wiest, Lehner-Baumgartner, & Baumgartner, 2006). According to the patient, his ability to recollect autobiographical episodes had been decreasing slowly since childhood. This finding was consistent with previous studies that reported that individuals with bilateral amygdala damage had more difficulty in recalling and describing emotional events, specifically emotional events associated with anger and fear, in relation to healthy individuals (Fink et al., 1996; Markowitsch et al., 2000; Siebert et al., 2003).

The inconsistent findings from the studies reviewed demonstrate a need for further exploration and further research to explain the implications of amygdala damage on subjective emotional experiences.

Specific Aims and Hypotheses

This study aimed to produce further data concerning the role of the amygdala in the processing of anger and fear. An investigation into the subjective affective states of individuals with UWD, who are known to have damage to their amygdala as a natural result of their illness, can provide deeper insight into the implications of amygdala damage on subjective emotional experiences. Data relating specifically to the subjective emotional experiences of UWD patients has been sparse. The limited data that is available has focused on the subjective emotional experiences of UWD patients after amygdala calcification. No previous study has analysed the changes of the subjective emotional experiences between childhood and adulthood as described retrospectively by the patient him/herself.

Because past studies have found that the amygdala calcifies as a result of UWD, it can be inferred that the experience of negative affect will be reduced, if not completely absent, for individuals diagnosed with UWD. Therefore, the following hypotheses were tested:

H_1: In an adult population with damage to the amygdala, as is found in individuals diagnosed with UWD, the degree of subjective experience of anger and fear is lower when compared to the degree of subjective experience of anger and fear of a matched adult healthy population.

H_2: In an adult population with damage to the amygdala, as is found in individuals diagnosed with UWD, the subjective experiences of anger and fear are experienced less often when compared to the same population's childhood subjective experiences of anger and fear.

Methods

Research Design and Setting

The current study was a cross-sectional comparison of two groups: an Urbach-Wiethe Disease (UWD) group and a healthy control (CON) group. The method employed to collect data was quasi-experimental, as participants were divided into groups based on the pre-existing criterion of a diagnosis of UWD. UWD participants were compared to each other based on scores obtained from the participants' rankings of the overall subjective experience of anger/fear and other emotions in childhood and adulthood, as well as the emotional intensity of recalled emotional events described in their semi-structured interviews. Furthermore, the word-count used to describe childhood and adulthood autobiographical memories associated with happiness, sadness, anger and fear was compared. The same comparisons were subsequently conducted between the UWD and control groups.

The semi-structured interviews took place in the comfort of the participants' own homes in the Northern Cape, South Africa.

Participants

This study formed part of a broader research project for which ethical approval has been granted by the Ethics Committee of the UCT Department of Psychology (see Appendix A) and the Health Science Faculty of the University of Stellenbosch. It followed the ethical guidelines for research with human subjects outlined by the Health Professions Council of South Africa (HPCSA) and abided by the Helsinki, Finland, declaration guidelines of 'good clinical practice' (World Medical Association, 1964). Individuals who agreed to participate provided written, informed consent before the interviews commenced (see Appendix B and C). Furthermore, permission to tape record the interviews was obtained from the participants prior to the interviewing.

Sixteen women, aged 23 to 69 years, participated in this study. The experimental group (i.e., the UWD group) consisted of eight female patients recruited from a previously identified population of UWD patients living in the rural Northern Cape in South Africa (Van-Hougenhoucktulleken et al., 2004; Thornton et al., 2008). All UWD participants were diagnosed by a qualified clinician, independent of this study. The diagnosis of UWD was established through genetic and clinical means, namely clinical blood sampling and brain scans (Van-Hougenhoucktulleken et al., 2004; Thornton et al., 2008). Eight physically healthy women served as the control (CON) group. These participants were recruited from the same community as the UWD patients in the rural Northern Cape in South Africa.

Across the groups, participants were matched on race, age, gender, socio-economic status (SES), geographical location, home language, and level of education. Basic demographics are presented in Table 1.

Inclusion and exclusion criteria. Exclusion criteria for both groups included a history of head trauma. Control group participants diagnosed with any neurological condition/s as well as UWD participants diagnosed with any additional neurological condition/s were excluded from the study. A history of clinical psychiatric disease resulted in exclusion from the study. Although UWD occurs regardless of gender, the one male UWD patient who volunteered to participate in the study was found to suffer from a psychiatric/neurological disease (i.e., alcoholism), and was therefore excluded.

Measures

General measures. Participants were asked to provide basic demographical information before the interviews commenced. This information was necessary for identification of participants who met exclusion criteria. Furthermore, information necessary for matching of UWD and control participants such as the participants' age, sex, and socioeconomic status was obtained from the participants.

Subjective experience of basic emotions. Although emotional scales, such as the Positive and Negative Affect Schedules (Watson, Clark, & Tellegen, 1988) have been used in the past to measure individuals' feelings or current predisposition, no emotional scale is as yet available to rate retrospective recall of subjective emotional experiences in childhood and adulthood.

A semi-structured interview was designed for the purpose of the broader study (Appendix D), of which only certain sections were used for the current study. The interview questions were based on Ekman's definitions of happiness, sadness, anger and fear. For the purpose of this aspect of the larger study, only Sections E and J (i.e., the participants ranking of their subjective experience of anger/fear compared to other emotions in childhood and adulthood) and Section F and K (i.e., the participants description of autobiographical memories of happy, sad, angry, and fearful events in childhood and adulthood) were rated and analysed using descriptive statistics.

Measures of subjective experience of anger/fear compared to other emotions in childhood and adulthood. Participants were asked to rank their overall experience of anger, fear, happiness, and sadness in order of dominance in childhood and adulthood (1st – most dominant, 4th – least dominant). The number of participants ranking anger or fear as the most dominant in childhood and adulthood were combined and compared to the number of participants that ranked happiness and sadness (other emotions) as the most dominant emotion in childhood and adulthood.

Measures of word-count for description of emotional events in childhood and adulthood. As the majority of the data collected for this study was subjective in nature, comparing the number of words used to describe emotional autobiographical events provided a more objective measurement of this data, and was included for this reason. Participants were asked to recall and describe happy, sad, angry, and fearful events in childhood and adulthood. The word-count of each recalled emotional event was compared within and between the two groups.

Measures of intensity of description of recalled emotional events in childhood and adulthood. Four-point rating scales were developed to guide the evaluation of the responses provided by the interviewees. Development of these scales was an iterative process that began with defining the interview rating dimensions based on Ekman's (1973) definitions of the basic emotions. Subsequently, the scales were used to measure the emotional intensity of the description of recalled events in childhood and adulthood. Intensity was rated as either absent (rating of 0), mild (rating of 1), moderate (rating of 2), or intense (rating of 3).

Interviewer. The interview questions were administered by a female nurse, who had an established relationship with the UWD patients as a result of having cared for them over many years prior to the interview. Prior to conducting the interviews, the nurse was trained by the principal researcher (i.e., of the broader study) to administer the interviews.

Independent raters. Three independent raters, with knowledge of Ekman's definitions of basic emotions, were recruited from the Psychology department of the University of Cape Town. All raters were fluent in Afrikaans, the language used during the interviews. They were provided with only the transcribed interviews, and care was taken that they were blind to the clinical status of the participants. Prior to rating the interviews, the raters were trained to accurately evaluate the interview responses. They were informed which rating scales were relevant to each question, and were taught to consider the answer to each question separately. When these independent ratings were complete, the raters shared their ratings with each other. The questions for which the ratings were within one point of each other were used for the study without further discussion. For ratings that varied by more than one point, the raters relayed their rationale for their ratings and discussed until consensus was reached within one point. All data analyses reported are based on the consensus ratings reached by the raters.

Procedure

This study formed part of a broader research project involving individuals with UWD, wherein the correlation of complete bilateral amygdala lesions and depression was researched. The study reported here was concerned only with the implications that bilateral amygdala lesions have for the subjective experience of anger and fear.

Participants were provided with basic information about the study (Appendix B) and written informed consent was obtained from all participants before the interviews commenced (Appendix C). Furthermore, participants were asked to complete a demographic

questionnaire before the interviews began, so as to ensure that all participants met the inclusion criteria.

Semi-structured interviews took place over two 2-hour sessions on two consecutive days. Interviews were audio recorded so as to capture the interview verbatim. The interviews contained standardised questions, which were asked during a semi-structured conversation between a trained nurse and the participant. The interviewer was flexible and willing to rephrase the questions, ensuring they made sense to the participant. The nurse chosen to conduct the interviews had adequate skills in interviewing and guided conversation techniques, and was familiar with the UWD participants and their language (Afrikaans).

The first session consisted of a two-hour semi-structured biographical interview. This interview emphasised the participant's emotional experiences and attitudes. During the second session, the participant was asked to recall and discuss significant emotional events in her life. The interview questions were specifically designed to encourage the recall of events that triggered the four basic emotions of anger, fear, sadness, and happiness.

A debriefing session was held prior to the end of the second assessment session, during which the participant was asked if any psychological or medical issues had arisen as a consequence of their participation in the study. If this was the case, the researcher gave the participant a list of suitable referrals, such as a psychological therapist or medical practitioner in the area. The participant was then thanked and given monetary compensation for her participation in the study.

Data Analysis

All statistical analyses were performed using SPSS version 19. The alpha level of $p = .01$ was used in all decisions regarding statistical significance in an attempt to decrease the probability of making a Type I error, as the sample size was small. Unless otherwise stated, all assumptions were met.

Descriptive statistics. The first stage of data analysis involved examining the descriptive statistics. This allowed for derivation of measures of central tendency and of variation, a description of the distribution of the various dependent variables (i.e., scores of the various emotional responses), detection of outliers, and determination whether the assumptions underlying subsequent inferential analyses were met.

Analysis of data from general measures. To characterise between-groups differences in demographic variables, independent samples T-tests were conducted for

continuous data (e.g., *age* and *level of education*), and chi-squared analysis for the categorical variable of *employment*.

Analysis of data from measures of subjective experiences of anger/fear versus other emotions in childhood and adulthood

Descriptive analysis was employed to compare within-groups and between-groups differences in the participant's ranking of their overall experience of anger/fear and other emotions (i.e., happiness and sadness) during childhood and adulthood. Descriptive statistics compared the within-groups and between-groups differences between the means of the number of participants' who had ranked anger/fear and other emotions as either 1st, 2nd, 3rd, or 4th overall dominant emotion in childhood and adulthood. Furthermore, a repeated-measures T-test was conducted to test whether there was a statistically significant within-group difference in the number of UWD participants' ranking of overall experience of anger/fear in childhood and adulthood.

Analysis of data from measures of word-count for description of emotional events in childhood and adulthood. A factorial ANOVA was employed to investigate whether Group (i.e., UWD and CON) and/or time of event (i.e., childhood and adulthood) was related to the number of words used to describe an autobiographical memory (i.e., happy, sad, angry, or fearful event).

Analysis of data from measures of intensity of description of emotional events in childhood and adulthood. Descriptive analysis was employed to characterise within-groups and between-groups differences in the emotional intensity of the description of autobiographical memories (i.e., happy, sad, angry or fearful event) in childhood and adulthood.

Results

The descriptive and inferential analyses of continuous data involved within-groups and between-groups comparisons to assess the difference in the participant's rankings of their overall subjective experiences of anger/fear compared to other emotions in childhood and adulthood. Furthermore, descriptive and inferential analyses were conducted to compare the word-count and emotional intensity of the description of events that triggered happiness, sadness, anger and fear in childhood and adulthood between the UWD and control groups. In this regard, two separate analyses were done to ensure that the UWD participants were matched sufficiently with the control group. Chi-squared analyses of categorical data sought

to establish whether there were statistically significant between-groups differences between the variable of employment, and independent samples T-tests were conducted to determine whether there were any statistically significant between-groups differences on the continuous variables of age and level of education.

All measures were first analysed using descriptive statistics. One measure was subsequently analysed using repeated-measures T-tests, and one measure was analysed using Factorial ANOVA. For most variables, all the assumptions underlying these tests were met. In some cases, Levene's test for homogeneity of variance was statistically significant, but all other assumptions were upheld and therefore the analysis proceeded conventionally as ANOVA is robust.

Measures of Sociodemographic Characteristics

Independent samples T-tests revealed no significant between-groups difference in age between the UWD and control groups, $t(13) = .29$, $p = .775$, as well as no significant between-groups difference in level of education between the UWD and control groups, $t(13) = -.420$, $p = .681$. Furthermore, chi-squared analysis indicated no significant difference in employment across the two groups, $x^2(2, N = 16) = 3.13$, $p = .210$. Demographic information is presented in Table 1.

Table 1
Demographic Characteristics of the Current Sample

Variable		*UWD* (*n* = 8)	*CON* (*n* = 8)	*p*
Age Range		37	46	
Age (Years)				
	Mean (SD)	46 (14.31)	43.7 (16.07)	.775
Gender				
	Male : Female	0 : 8	0 : 8	
Home Language				
	Afrikaans : English : Other	8 : 0	8 : 0	
Ethnicity				
	White : Coloured	0 : 8	0 : 8	
Employment				
	Employed : Unemployed : Retired	2 : 5 : 1	5 : 2 : 1	.210
Level of Education (Grade)				
	Mean (SD)	8.75 (3.01)	9.28 (1.60)	.681

Note. UWD = Urbach-Wiethe Disease group; CON = Control group.
For Age and Level of Education, means are presented with standard deviations in parentheses.

Subjective Experiences of Anger/Fear versus Other Emotions in Childhood and Adulthood

A within-groups comparison of the UWD participants' ranking of their overall experience of the emotions predicted to be correlated with a functioning amygdala (anger/fear) and other emotions predicted to be independent of a functioning amygdala (i.e., happiness and sadness) was conducted using descriptive statistics (see Table 2 in Appendix E for descriptive results).

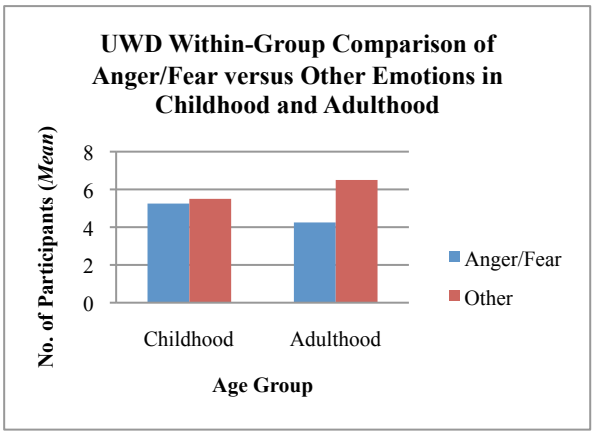

Figure 1

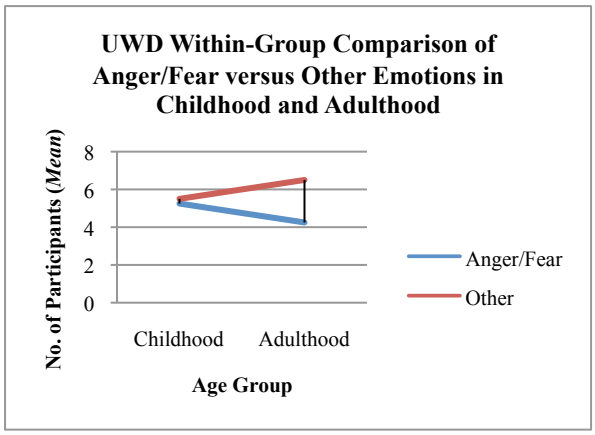

Figure 2

UWD group. As illustrated in Figure 1 and 2, within the UWD group the experience of anger/fear was similar to the experience of other emotions, although less of the other emotions were experienced in childhood ($M = 5.50$, $SD = 1.51$) than in adulthood ($M = 6.50$, $SD = .53$). However, the UWD participants experienced more anger/fear in childhood ($M = 5.25$, $SD = 1.58$) than in adulthood ($M = 4.25$, $SD = 1.16$).

A repeated-measures T-test was conducted to test whether the difference in anger/fear experience between childhood and adulthood within the UWD group was statistically significant. The analysis yielded a non-significant result, $t(7) = 1.87$, $p = .052$. However, had the significance level not been adjusted to $\alpha < .01$, this result would have been approaching statistical significance.

Control group. As can be seen in Figure 3 and 4, the control group participants experienced more anger/fear in adulthood ($M = 5.25$, $SD = 2.05$) than in childhood ($M = 4.38$, $SD = 1.19$), and more of the other basic emotions in adulthood ($M = 7.13$, $SD = .64$) than childhood ($M = 6.00$, $SD = 1.07$).

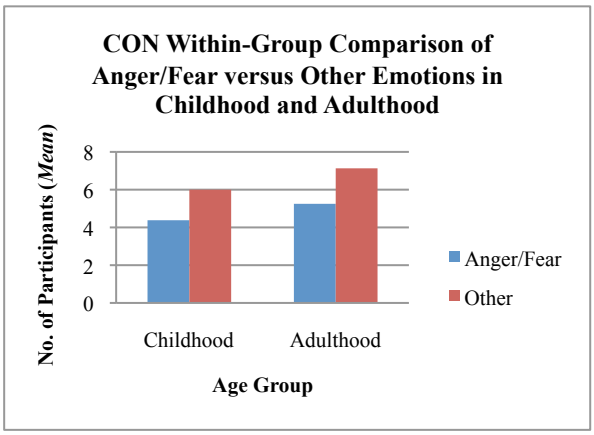

Figure 3

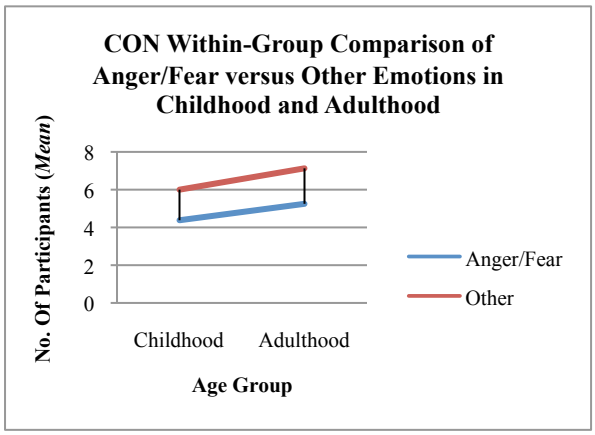

Figure 4

UWD vs. Control group. As can be seen in Figure 5, 6, 7, and 8, the number of UWD participants ranking anger/fear as their dominant emotion in childhood ($M = 5.25$, $SD = 1.58$) was higher than the number of control group participants ranking the same emotions in childhood ($M = 4.38$, $SD = 1.19$). This reversed in adulthood, when fewer UWD participants ranked anger/fear as most dominant ($M = 4.25$, $SD = 1.16$) than the control group ($M = 5.25$, $SD = 2.05$). The number of participants ranking the other emotions as more dominant in childhood (UWD: $M = 5.50$, $SD = 1.51$; control group: $M = 6.00$, $SD = 1.07$) increased for both groups in adulthood (UWD: $M = 6.50$, $SD = .53$; control group: $M = 7.13$, $SD = .64$) (see Table 2 in Appendix E for descriptive statistics).

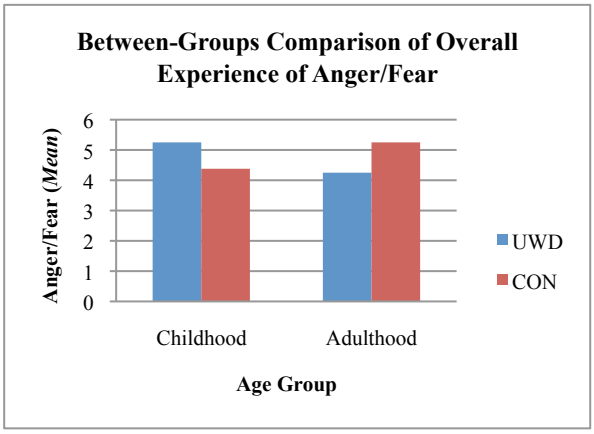

Figure 5

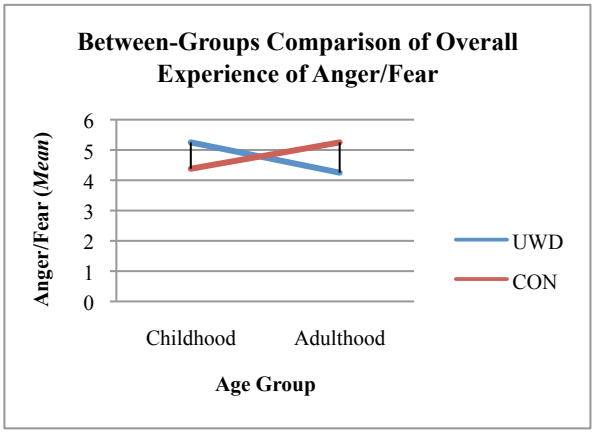

Figure 6

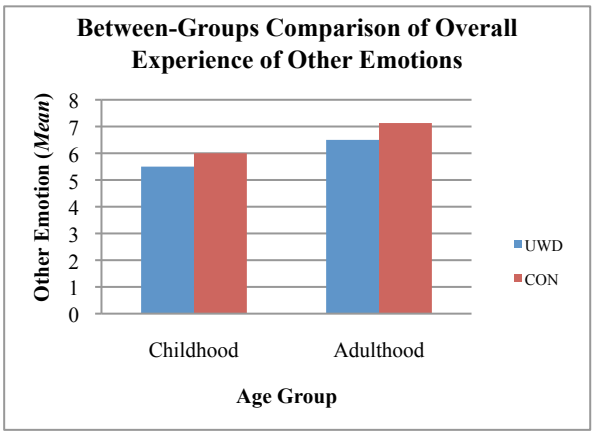

Figure 7

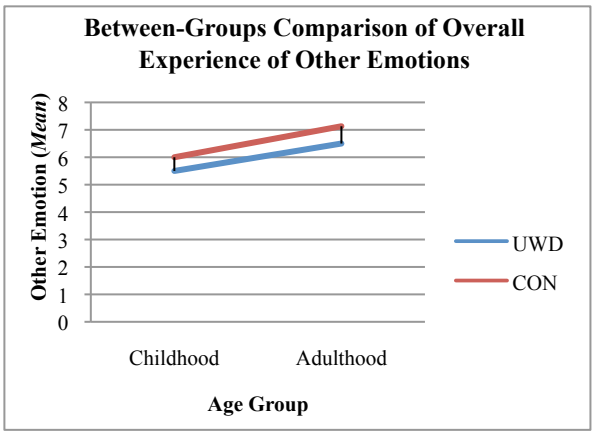

Figure 8

Summary of results: Although all statistical results were non-significant, descriptive analyses indicated that the number of UWD participants ranking anger/fear as the most dominant emotion decreased from childhood to adulthood, while it increased within the control group. The number of participants ranking other emotions as most dominant increased within both groups from childhood to adulthood. The results of the between-groups measure resembled a double dissociation.

Word-Count of Description of Emotional Events in Childhood and Adulthood

The number of words used to describe emotional events are presented in Table 3. Within-groups and between-groups differences in word-count in childhood and adulthood are evident.

Table 3

Measure of Word-Count Used to Describe Emotional Events

	Group			
	UWD (n=8)		CON (n=8)	
Event Type	Childhood	Adulthood	Childhood	Adulthood
Happy	43.88 (25.98)	69.63 (45.68)	141.88 (109.30)	186.13 (268.48)
Sad	59.00 (91.61)	99.88 (74.67)	180.38 (124.35)	266.75 (313.80)
Angry	50.25 (58.73)	63.88 (64.91)	36.88 (54.58)	122.00 (146.32)
Fearful	29.38 (27.53)	58.75 (70.03)	120.38 (106.36)	99.87 (135.62)

Note: Means presented with standard deviations in parentheses.

Within-groups. Figures 9 and 10 illustrate within-groups differences in the number of words the participants used when recalling emotional events in childhood and adulthood.

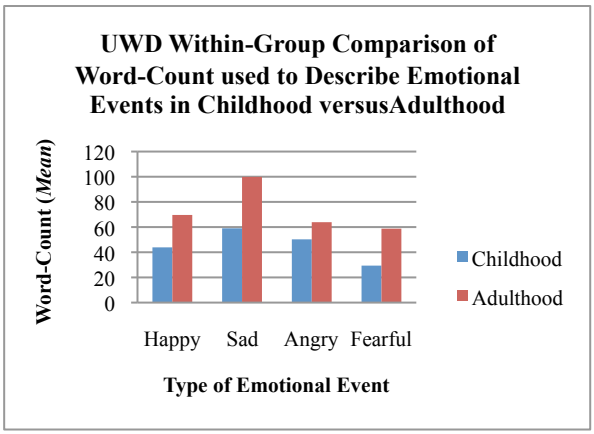

Figure 9

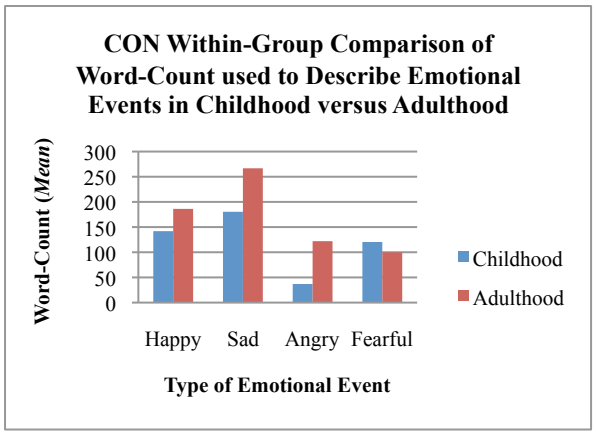

Figure 10

As can be seen in Table 3, the UWD participants used more words to describe emotional events in adulthood than in childhood, with most words being used for sad events, regardless of time of event (childhood: $M = 59.00$, $SD = 91.61$; adulthood: $M = 99.88$, $SD = 74.67$). In adulthood, UWD participants used the least words to describe angry ($M = 63.88$, $SD = 64.91$) and fearful ($M = 58.75$, $SD = 70.03$) events. Fearful events were described with the least words for in both childhood ($M = 29.38$, $SD = 27.53$) and adulthood by the UWD participants. The number of words used to describe emotional events by the control group followed a similar trend, although the word-count for fearful events decreased from childhood (M = 120.38, SD = 106.36) to adulthood (M = 99.87, SD = 135.62).

Between-groups. Figures 11 and 12 illustrate between-groups differences in the number of words the respective groups used when recalling emotional events in childhood and adulthood.

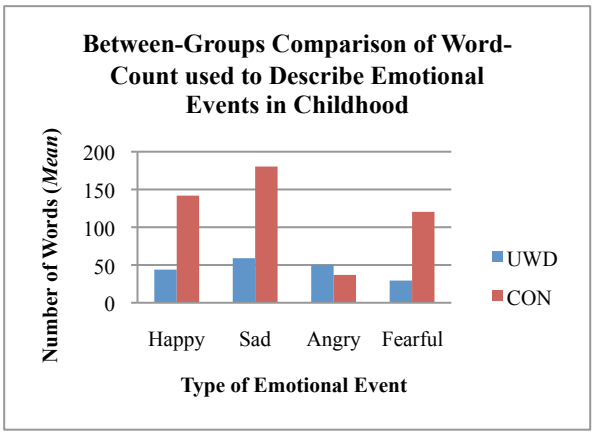

Figure 11

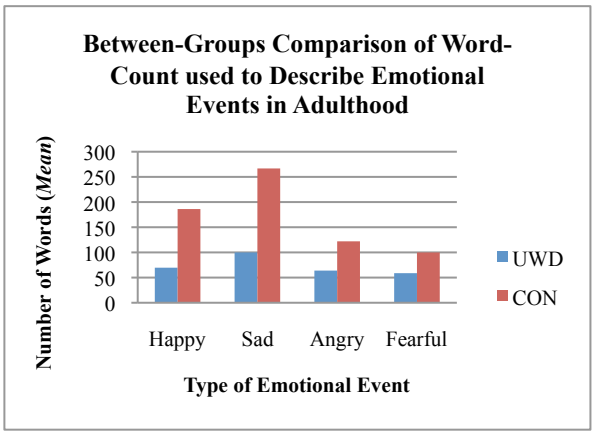

Figure 12

With the exception of the angry event in childhood, the control group participants used noticeably more words to describe both childhood and adulthood events, regardless of the type of emotional event. Although the group difference in word-count of happy and sad events remained relatively similar between childhood and adulthood, less difference was noted between the word count for fearful events in childhood (UWD: $M = 29.38$, $SD = 27.53$; control group: $M = 120.38$, $SD = 106.36$) than in adulthood (UWD: $M = 58.75$, $SD = 70.03$; control group: $M = 120.38$, $SD = 106.36$). UWD participants used more words to describe angry events in childhood ($M = 50.25$, $SD = 58.73$) than the control group ($M = 36.88$, $SD = 54.58$), while this reversed in adulthood (UWD: $M = 63.88$, $SD = 64.91$; control group: $M = 122.00$, $SD = 146.32$).

Four separate factorial ANOVA tests were employed to test whether group membership (i.e., UWD or control group) had an effect on any within-groups and between-groups differences in the amount of words used to describe recalled emotional events of happiness, sadness, anger and fear.

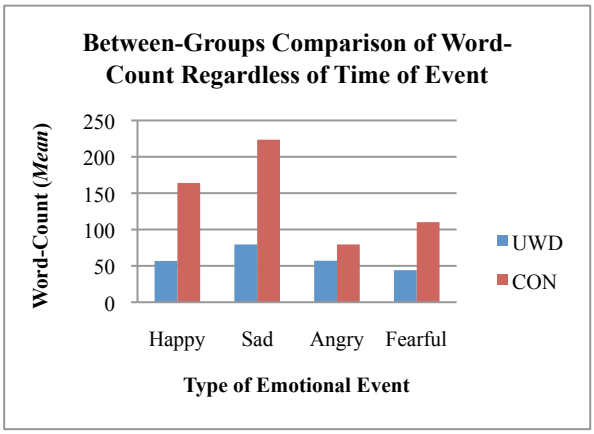

Figure 13

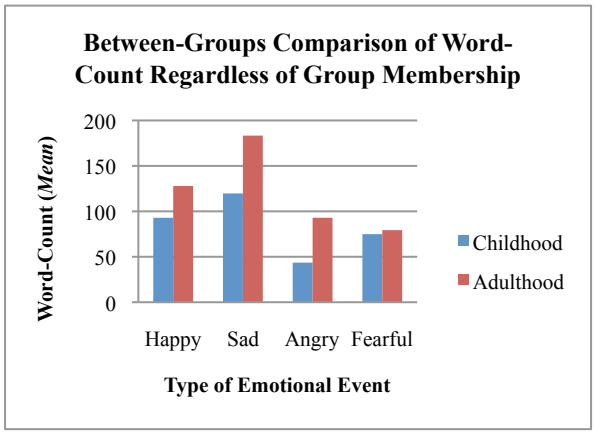

Figure 14

As illustrated in Figure 13 and 14, less words were used to describe *angry* events (UWD: $M = 57.06$, $SD = 60.21$; control group: $M = 79.44$, $SD = 115.39$) and *fearful* events (UWD: $M = 44.06$, $SD = 53.59$; control group: $M = 110.13$, $SD = 118.21$), regardless of time of event. Similarly, less words were used to describe *angry* events (childhood: $M = 43.56$, $SD = 55.21$; adulthood: $M = 92.94$, $SD = 113.39$) and *fearful* events (childhood: $M = 74.88$, $SD = 88.55$; adulthood: $M = 79.31$, $SD = 106.41$), regardless of group membership.

With regard to word-count for *happy* events, the results of the factorial ANOVA indicated that there were no statistically significant effects for group membership $F(1, 28) = 4.24$, $p = .049$, nor for time of event $F(1, 28) = .45$, $p = .507$. Furthermore, no statistically significant interaction effect was found for group membership and time of event

$F(1, 28) = .86$, $p = .860$. The effect sizes for group membership ($n^2 = .13$) and time of event ($n^2 = .02$) were small (see Table 4 in Appendix E for a summary of the ANOVA results).

With regard to word-count for *sad* events, Levene's was statistically significant, $p < .01$, indicating that the between-groups variances were not homogenous. The results of the factorial ANOVA indicated that there was no statistically significant effect for group membership $F(1, 28) = 5.20$, $p = .030$, nor for time of event $F(1, 28) = 1.01$, $p = .323$. Furthermore, no statistically significant interaction effect was found for group membership and time of event $F(1, 28) = .13$, $p = .722$. The effect sizes for group membership ($n^2 = .16$) and time of measurement ($n^2 = .04$) were small (see Table 5 in Appendix E for a summary of the ANOVA results).

With regard to *angry* events, the results of the factorial ANOVA indicated that there was no statistically significant effect for group membership $F(1, 28) = .50$, $p = .485$, nor for time of event $F(1, 28) = 2.43$, $p = .130$. Furthermore, no statistically significant interaction effect was found for group membership and time of event $F(1, 28) = 1.28$, $p = .268$. The effect sizes for group membership ($n^2 = .02$) and time of event ($n^2 = .08$) were small (see Table 6 in Appendix E for a summary of the ANOVA results).

With regard to *fearful* events, the results of the factorial ANOVA indicated that there was no statistically significant effect for group membership $F(1, 28) = 3.95$, $p = .057$. This result would have been approaching statistical significance, had the significance level not been adjusted to $\alpha < .01$. No statistically significant result was found for time of event $F(1, 28) = .02$, $p = .895$. Furthermore, no statistically significant interaction effect was found for group membership and time of event $F(1, 28) = .56$, $p = .459$. Levene's test was significant, $p < .01$, indicating that the assumption of homogeneity of variance was not met. The effect sizes for group membership ($n^2 = .12$) and time of event ($n^2 = .001$) were small (see Table 7 in Appendix E for a summary of the ANOVA results).

Summary of results: The results of the factorial ANOVA indicated that neither group membership (i.e., UWD or control group) nor time of event (i.e., childhood or adulthood) had a statistical significant effect on any within-groups and between-groups differences in the amount of words used to describe recalled emotional events of happiness, sadness, anger or fear. Furthermore, no statistically significant interaction effect was found for group membership and time of event. Although all statistical result were non-significant, potentially due to the small sample size**,** descriptive statistics showed that there were some differences in the within-groups and between-groups comparisons of word-count used to describe the emotional events. Both the UWD and control group participants used more

words to describe happy and sad events in adulthood than in childhood, with the control group using more words than the UWD group regardless of time of event. Although both groups used more words to describe angry events in adulthood compared to childhood, the UWD group used more words to describe angry events in childhood than the control group. This reversed in adulthood, at which time the control group used more words than the UWD group. The control group used more words than the UWD participants to describe both childhood and adulthood fearful events, although the word-count for fearful events decreased for the control group in adulthood, while it increased for the UWD group in adulthood.

Intensity of Descriptions of Emotional Events in Childhood and Adulthood

Within-groups. Figures 15 and 16 illustrate within-groups differences in the intensity of the recalled emotional events in childhood and adulthood.

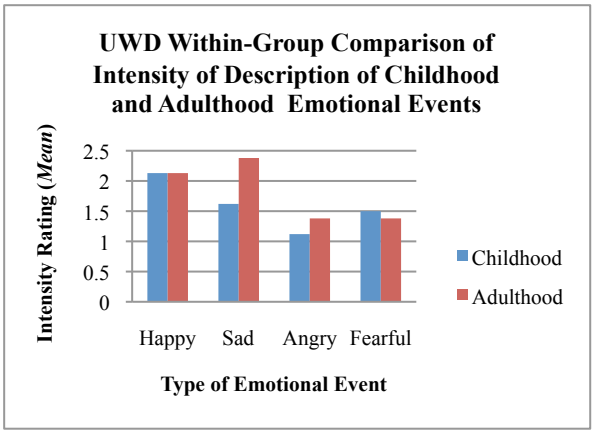

Figure 15

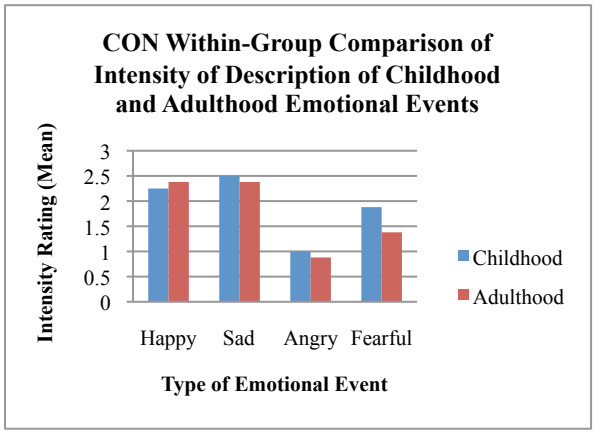

Figure 16

UWD group. When recalling emotional events from childhood, UWD participants most intensely described happy events (M = 2.13, SD = .35), followed by the sad events (M = 1.62, SD = 1.30), then fearful events (M = 1.50, SD = 1.31) and lastly angry events (M = 1.12, SD = .99). The description of emotional events in adulthood was most emotionally intense for the sad event (M = 2.38, SD = .74), followed by the happy event (M = 2.13, SD = .35). The least emotional intensity was found in the recall of both angry (M = 1.38, SD = .74) and fearful (M = 1.38, SD = 1.06) adulthood events. The intensity of emotional expression increased from childhood to adulthood for the sad and angry events, remained the same for the happy event, and decreased in intensity for the fearful event. The largest difference in intensity of description was found for sad events (MD = .75), followed by angry event (MD = .25) and fearful event (MD = .13).

Control group. When recalling emotional events from childhood, control group participants most intensely described sad events (*M* = 2.50, *SD* = .76), followed by the happy events (*M* = 2.25, *SD* = 1.04), the fearful events (*M* = 1.88, *SD* = 1.13) and lastly angry events (*M* = 1.00, *SD* = 1.20). A similar trend was noted in adulthood, for which time both happy (*M* = 2.38, *SD* = .74) and sad (*M* = 2.38, *SD* = 1.06) events were expressed with more intensity, followed by fearful events (*M* = 1.38, *SD* = 1.30) and angry events (*M* = .88, *SD* = .83). The intensity of expression of happy events increased from childhood to adulthood, while the intensity of expression decreased for sad, angry and fearful events. The largest difference of intensity between the description of specific emotional events in childhood compared to adulthood was found in the expression of the fearful event (*MD* = .5), followed by both angry and sad events (*MD* = .13) and lastly happy events (*MD* = .13)

Between-groups. As illustrated in Figure 17, the control group described happy emotional events in adulthood with more intensity than the UWD group, while the intensity of description of the sad and fearful events was the same for both groups. However, both groups described the fearful events in adulthood with less intensity that happy and sad adulthood events. The UWD group expressed more intensity of emotion for the angry event than the control group. The least emotional intensity was noted in the control groups' description of recalled angry events (see Table 8 in Appendix E for the descriptive of the intensity ratings of recalled emotional events in childhood and adulthood).

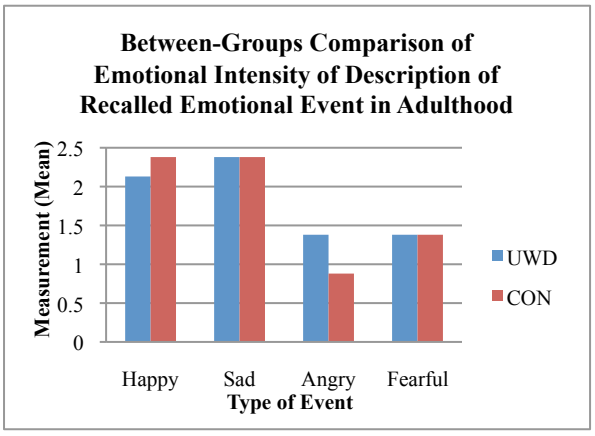

Figure 17

Summary of results: Descriptive analyses showed that the emotional intensity of the description given by both the UWD and control group participants for happy events remained the same in childhood and adulthood. UWD participants used more emotionally intense descriptions for sad and angry events in adulthood, while the intensity of description of fearful events decreased in adulthood for UWD participants. The control group used more

emotionally intense descriptions for sad, angry and fearful events in childhood compared to adulthood. Angry events were expressed with the least intensity by the control group participants, followed by fearful events.

Discussion

On the basis of previous studies, the current study hypothesised that UWD patients with bilateral amygdaloid damage would have fewer subjective experiences of fear and anger, but similar subjective experiences of other emotions (i.e., happiness and sadness) in comparison to individuals with a healthy amygdala. Furthermore, the current study predicted that the subjective experience of anger and fear should decrease for UWD participants in adulthood, while their subjective experience of other emotions should remain the same or increase in adulthood. Although descriptive analyses were consistent with the hypotheses, none of the inferential tests resulted in statistically significant results. This, however, may have been due to the small sample size. A decrease in subjective experiences of anger and fear were found in UWD patients in comparison to healthy controls, and decreased subjective experiences of anger and fear were found in UWD adulthood experiences compared to their childhood experiences. Furthermore, both groups showed a similar increase in subjective experiences of other emotions in adulthood compared to childhood. How these findings relate to changes in the subjective emotional experiences of individuals with amygdala damage, and how these findings relate to previously published research findings, will be discussed.

Subjective Experiences of Anger/Fear versus Other Emotions in Childhood and Adulthood

Overall, the results showed that UWD participants' ranking of their dominant experience of anger/fear decreased from childhood to adulthood, while the inverse pattern was found for control group participants. These between-groups results resembled a double dissociation, although no statistically significant difference could be found due to the small sample size. The difference of UWD participants' ranking of overall dominant experience of anger/fear in childhood compared to adulthood was found to be approaching statistical significance with a p value of .052. As the significance level was adjusted to $\alpha < .01$, due to the small sample size, the result suggests that a larger sample size could potentially have provided a statistically significant result.

The participants' ranking of overall dominant experience of other emotions (i.e., happiness and sadness) increased in adulthood for both UWD and control group participants,

although the control group ranked their overall dominant experience of the other emotions in both childhood and adulthood higher than did the UWD group. These findings were consistent with past studies that found that the overall dominant experience of anger and fear were dependent on a healthy functioning amygdala, while the subjective experiences of the other emotions did not show such dependency (Adolphs, 2003; Adolphs & Spezio, 2006; Anderson et al., 2000; Davis & Whalen, 2001; Dillon et al., 2011; Phillips et al., 2001; Tranel, Gullickson, et al., 2006).

In summary, though no statistically significant results were found, the current data supports the idea that bilateral damage to the amygdala decreases the overall dominant subjective experience of anger/fear, while having no effect on the overall dominant subjective experiences of other emotions.

Word-Count for Description of Emotional Events in Childhood and Adulthood

As expected, UWD individuals (i.e., individuals with bilateral amygdala damage) used fewer words than the control group when describing autobiographical episodic memories. This finding is consistent with the literature indicating that the amygdala is important to memory retrieval of episodic autographical information (Fink et al., 1996; Markowitsch, 1995, 1999; Markowitsch et al., 2000; Wiest & Brainin, 2010; Wiest et al., 2006). Had it not been for the adjusted significance level (i.e., $p < .01$), group membership on word-count would have been statistically significant for happy and sad events, and approaching statistical significance for fearful events, regardless of the time of the event. Though small, the effect sizes for these measures were similar. Future studies with a larger sample group may potentially find a statistically significant result and larger effect sizes for these measures.

Furthermore, descriptive statistics showed that UWD participants used fewer words to describe angry and fearful autobiographical memories than those related to happy and sad events, regardless of the time of the recalled event. This finding is consistent with past research that found that individuals with bilateral amygdala damage had more difficulty in recalling and describing autobiographical memories associated with anger and fear than memories associated with other emotions (Fink et al., 1996; Markowitsch et al., 2000; Siebert et al., 2003).

A particular point of interest with regard to recall of angry events was that although the UWD participants used more words than the control group to describe angry events in childhood, they used noticeably fewer words than the control group participants to describe

angry events in adulthood. The apparent decreased ability to recall and describe angry events in adulthood, compared to angry events in childhood, suggests a dependency on a functioning amygdala for recall and description of autobiographical memories associated with anger. An example of participants' descriptions of angry adulthood events is provided in Appendix E.

In summary, though no statistically significant results were found, the current data supports the idea that bilateral damage to the amygdala decreases the ability to recall and describe episodic autobiographical memories, specifically events related to anger and fear.

Intensity of Description of Emotional Events in Childhood and Adulthood

As expected, UWD individuals described angry and fearful autobiographical memories with less intensity than memories associated with happy and sad events. This is in line with the literature that reported that patients with bilateral amygdala lesions had more difficulty in encoding, recalling, and emotively describing emotional events associated with anger and fear than other emotions (Adolphs & Tranel, 2004; Drevets, 2003; Staut & Naidich, 1998; Thornton et al., 2008; Tranel & Hyman, 1990; Van-Hougenhoucktulleken et al., 2004). In addition to this, the emotional intensity of the description of autobiographical memories of happy, sad, and angry events remained the same or increased in adulthood for the UWD participants, while the emotional intensity of the description of fearful events decreased in adulthood. These findings were consistent with studies that have found that the amygdala is activated by fear-evoking stimuli, rather than stimuli evoking other types of emotion, such as anger, sadness, or happiness (Irwin et al., 1996; Morris et al., 1996; Phillips & Young, 1997), but inconsistent with previous studies that found that the recall of both fearful and angry memories depend on amygdala function (Fink et al., 1996; Markowitsch et al., 2000; Siebert et al., 2003). However, the difference in emotional intensity of the UWD participants' description of angry childhood and adulthood events was relatively small (*MD* = .25), and may have been effected by the small sample size. Future studies are required to clarify the inconsistency of this finding with past research.

The results of the between-groups comparison were inconsistent with past research. The results indicated that the emotional intensity of recall of autobiographical memories was similar between the groups for happy, sad, and fearful adulthood events. However, past findings dictate that the emotional intensity of descriptions of fearful memories should be lower for UWD participants (Fink et al., 1996; Markowitsch et al., 2000; Siebert et al., 2003). A possible explanation for this result may be that the description of fearful memories in adulthood was reported at the end of the interview, after the other descriptions of all other

memories. Although this was the case for both groups, the control group had expressed more emotional intensity throughout the interview, and may have been feeling greater emotional fatigue than the UWD participants by this late stage of the interview. Future studies, in which recall of fearful autobiographical memories are described first, will potentially provide insight into these findings.

Consistent with previous studies was the emotional intensity of the described angry events in adulthood, which was lower for the UWD participants than the control group. Appendix F provides an example of the difference in intensity of recall and description of angry events in adulthood between an UWD and a control group participant.

In summary, though no statistically significant results were found, the current data supports the idea that bilateral damage to the amygdala decreases the ability to recall and describe autobiographical memories with emotional intensity, specifically recalled events related to fear.

Limitations and Future Directions

The limitations of the current study are discussed below. Also discussed are the ways in which future research studies might address these limitations.

Participants. A major limitation of the current study was the small sample size. As noted earlier, UWD is a very rare disease, and of the 60 individuals living in the Northern Cape in South Africa who have been diagnosed with UWD, only eight female individuals were available and eligible to participate in this study. As a result of the small sample size, some of the assumptions of normality of data distribution and homogeneity of variance were violated, threatening the reliability of the results. Due to the small sample size, analyses lacked statistical power. This is reflected in the large standard deviations in the results of statistical analysis done for this study. More importantly, as a result of the small sample size, only tentative conclusions can be drawn from the findings of this study. Future investigations are necessary and would benefit from larger sample sizes.

Past studies of UWD patients discuss the implications of certain symptoms often present in individuals with UWD that can hinder the research process. For example, a hoarse voice and a thickening sublingual frenulum leading to restricted tongue movement, as well as facial skin infections are consistent clinical features of this disease (Thornton et al., 2008; Van-Hougenhoucktulleken et al., 2004). These symptoms may not be seen as limitations, but they do indeed make the research process more difficult, as these individuals are often shy and become distressed when new people (e.g., the researcher) are introduced to them.

Familiarisation with the researcher/interviewer is one way of addressing this. The interviewer recruited for conducting the semi-structured interviews was well-known to the participants, enabling the participants to feel at ease and uninhibited by their clinical symptoms.

The current data was limited to a female population as it was difficult to recruit male participants due to the rarity of the disease, and because many of the male UWD patients suffer from psychiatric conditions. Although one male UWD patient volunteered to participate in this study, he was excluded based on his history of alcohol addiction. Male individuals who volunteered to participate in the control group were therefore excluded in the current study. Additional studies are needed to characterise the extent to which the observed results of this study also extend to men.

Nature of the data. The data used for the current research was non-numerical in nature, as it consisted of transcriptions of the participants' audio-recorded spoken words. Since the nature of the data was qualitative, which resists quantitative analysis, all data, with the exception of the measure of word-count, was not suitable for quantitative analyses. A more nuanced understanding of data of this nature could be obtained by combining quantitative and qualitative measures.

Conclusion

The role the amygdala plays in the processing of the basic emotions of anger and fear was investigated in UWD patients, who have selective bilateral amygdala calcification as a natural result of the disease, and a matched healthy control group. Overall, UWD participants expressed a decreased subjective experience of anger and fear in adulthood compared to childhood, while the subjective experience of other emotions increased in adulthood. Furthermore, UWD participants showed less subjective experience of anger and fear in adulthood when compared to the control group. These results were consistent with past research that found that the processing of anger and fear is dependent on a functioning amygdala.

Though past studies have identified the amygdala as a highly significant component of the neuronal networks that are involved in processing anger and fear, they have largely failed to address the subjective experiences of the participants and the implications amygdala damage has on their subjective emotional life as a whole. Therefore, past neurobiological emotion theories need to be adjusted and refined in order to be applicable to every individual who suffers from amygdala damage. Further investigation into the role of the amygdala in processing of subjective emotional experiences is necessary to gain a clearer understanding of

the emotional deficits present in individuals who have amygdala damage. This would be useful in improving management and treatment for these individuals. In conclusion, while the findings of the current study do not provide a complete account of which emotions depend on a healthy functioning amygdala, they provide support for the idea that anger and fear have such a dependency.

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Appendix A

Ethical Approval from the UCT Department of Psychology Ethics Committee

UNIVERSITY OF CAPE TOWN

Department of Psychology

University of Cape Town Rondebosch 7701 South Africa
Telephone (021) 650 3414
Fax No. (021) 650 4104

4 May 2009

Dr. Georg Fodor
c/o Department of Psychology
University of Cape Town
Rondebosch 7701

Dear Dr Fodor,

I am pleased to inform you that ethical clearance has been given for your project:

Emotional experience in Urbach-Wiethe Disease: A neuro-psychoanalytic study.

I wish you all the best for your study.

Yours sincerely,

Johann Louw PhD
Professor

Appendix B

Patient Information Sheet

You are invited to participate in a study researching the effects of Urbach-Wiethe disease on some aspects of cognition and emotion. Specifically, we are trying to document the way (if any) in which this disease influences the emotional life and memory of patients affected by it. If you consent to participate in this study, you will be required to complete 3 questionnaires and participate in two two-hour-long interviews on two consecutive days. The interviews will take place in a private consulting room and will be recorded. The first session will consist in a two hour biographical interview. In the second session you will be asked to recall and discuss emotional situations in your past that were of major significance to you. This will include asking you to remember and describe unpleasant emotional situations.

The data gathered from this research may be published, but your contribution and data will remain anonymous.

There are no anticipated personal risks involved in this research, apart from the temporary feelings associated with remembering distressing events.

Prior to the end of the interview there will be a debriefing session during which the interviewer will ask the interviewee whether there is anything arising of this interview that the interviewee feels needs further attention. If so, the necessary arrangements will be made during the period the researcher is still in the area. If the arising questions need further attention, the research team may choose to attend to it themselves or facilitate referral to local services (contact details of investigators see below).

You are free to withdraw from the study at any point, without having to provide a reason.

You will receive R 150 for your participation in this study.

NB: Your decision to participate or not participate will in no way impact on your ongoing medical care and treatment.

This study is being funded by the Hope for Depression Research Foundation, New York and has been reviewed by the UCT Psychology Department's ethics committee.

Should you have any questions or queries about the research or your participation, please do not hesitate to contact the investigators:

Georg Fodor: (cell) 071 3621310 (email) georg.fodor@uct.ac.za

Elda Storck : (cell) 082 9299700 (email) estorck@mweb.co.za

Appendix C

Consent Form

The study has been explained to me, and all my questions have been answered.

I understand that participation in this study is voluntary, and that I may withdraw at any point.

I understand that my anonymity will be maintained throughout the study and when the research is published.

I consent to participate in this research.

Name: _____

Signature: _____

Date: _____

I have explained the study to the participant, and in my opinion s/he understands that participation is voluntary and is able to give informed consent.

Researcher: _____

Signature: _____

Date: _____

Appendix D

Semi-Structured Interview Template

A. IDENTIFY THE NUMBER THE PARTICIPANT CHOSE; THIS IS THEIR I.D. FOR THIS RESEARCH

B. THE FOLLOWING SECTION IS INTRODUCTORY PATTER. RANK IN ORDER (1ST-7TH) YOUR OVERALL IMPRESSION OF THE PARTICIPANT'S DOMINANT EMOTIONAL TRAITS FROM THIS SECTION (‚SEEKING'/'LUST'/'FEAR'/'SADNESS'/'ANGER'/'PLAY'/'CARE') [THESE EMOTIONAL TYPES MUST BE DEFINED]

Could you tell me a little bit about your *current situation.:*
Where do you live? . . .in a house, a flat? . . .whereabout ist that?
Do you live alone or with your family? . . .so who are the people you live with? . . .and does anyone else live there?
So you're married/ . . .not married/. . . live with your partner and your children? . . .Do you have any children? . . .How many , how old ,? . . . . .
What is your vocational situation? . . .So you're employed./ self employed
Where is your workplace? How do you commute?
What exactly is what you're doing in your daily routine at work? Do you like what you are doing?
How is your social life ? Do you have many friends,? Do you meet them often? Are you rather with your family ? Do you go out a lot ? . . .meet friends in your or their home?
Do you have any hobbies? . . .Sport activities?
(If the interviewer knows the participant, different things will be asked like: How have you been doing lately?, how is the family? Your uncle recovered from the operation? What are the children doing? Did the promotion at your workplace happen? And the like.)
The idea of this introductory patter is to get started with a conversation, warm up, get a feel for the participant and allow them to get a feel for the Interviewer, get into an emotional relationship . . .
Birth, situation at home during early childhood, Mom, Dad, Siblings, early development, social situation among other children

I'd like to ask you now a few more things about yourself :
If that's OK I'd like to start with your personal history:
When and where were you actually born? . . .which city? at home or in a hospital? Why did your parents decide to do it at home/in hospital?
How old was your mother/father at your birth?
So Mom was rather old/young, father was rather old/young, the age difference beween Mom and Dad was small/big.
Were the parents married when you were born ?
After birth, with whom did you stay? With Mom/grandmom/parents – and who else lived in that household at that time?
Where was Mom/Dad/grandparents?
Were there any siblings? . . . older, younger, how many years?
Were there any uncles, aunts, cousins around?
Were there any changes of your situation during your early childhood years?

Did the family move withyou? Did anyone move in or out? Where any siblings born?
Did Mom/Dad work? What kind of work? Were they around or rather away a lot?
Who took care of you during an average day or night?
Do you have memories about that time of your life?
How was the atmosphere at home?
How was the economic situation, did you feel scarceness/poverty or did it feel like the parents could provide for everything you wanted?
Were there many people around – visiting or otherwise ?
Did Mom/Dad or anyone else tell you later how you were as a little child, how your life was as a little child?
Were you breastfed? Were there any problems with drinking, eating? . . .wit the teeth coming? . . .with toilet training? , . . How was it with your first steps walking?
How was Mom ? How did you get on with her?
How was dad? How did you get on with him?
How was it with your siblings, other children? How did you get on with them?
Were you an outgoing or a rather withdrawn child ?
Did you go to nursery school? Why not?
Did you like to go there? Was it easy/difficult for you in the beginning?
How did you get on with the nursery school teacher and the other children?

Situation as a school child at school . . .

When did you start school? How was it to go to school in the beginning?
Were you among the younger or the older children?
How did you get on with the other children in class?
How did you cope with the academic challenges?
Was the academic stuff easy/difficult for you to deal with?
Did you have to sit and learn a lot? How was your performance?
Did you like to learn?
How was your relationship with your teacher(s)?
Within the group of children, did you find yourself to be more a central figure – a leader – or rather in the middle? Or were you more at the fringes.
Did you have a best friend?

. . . and at home.

Were there any changes in your domestic situation during this period? (like moving, people moving in or out of your house, leaving, dying, siblings born)
How did your relationsship to the members of your familiy develope?
How was the relationship between Mom and Dad? . . .among other family members
Were you a lot with other children or did you rather play alone?
Did you persue any sport or hobbies?
Were there any diseases or accidents?
Did you loose any significant person?

C. THE FOLLOWING SECTION CONCERNS THE EXPRIENCE OF DIFFERENT EMOTIONS IN CHILDHOOD. THE PARTICIPANT'S RESPONSES TO THE FOUR QUESTIONS SHOULD BE RATED AS ‚YES'/‚NO'

In comparison with other children in your surrounding – did you play less, more, the same as other children?
Looking at your childhood - in summary –
Would you say that you had many friendships?

Did you ever feel really abandoned , alone?
Could you describe when, where, what kind of situation, who was around? Other details
Where you often happy ?
Could you describe when, where, what kind of situation, who was around? Other details
Where you often sad ?
Could you describe when, where, what kind of situation, who was around? Other details
Where you often frightened ?
Could you describe when, where, what kind of situation, who was around? Other details
Where you often angry ?
Could you describe when, where, what kind of situation, who was around? Other details

D. THE FOLLOWING SECTION CONCERNS CHILDHOOD EMOTIONS IN COMPARISON TO OTHER CHILDREN. THE RESPONSES SHOULD BE RATED ‚MORE'/‚LESS'/‚SAME'

And compared to other children – were you more/less/ the same/

Happy
Sad
Angry
Frightened

E. THIS SECTION CONCERNS THE PARTICIPANTS OWN RANKING OF THEIR PREDOMINANT CHILDHOOD EMOTIONS. THE RESPONSES IN THIS SECTION SHOULD BE RANKED 1ST/2ND/3RD/4TH

Which feeling would you say that you had most as a child.

Happy, sad, frightend, angry

. . . and second/third/ most?
Does that mean that the least often you felt . . . .?

F. THIS IS A VERY IMPORTANT SECTION; IT CONCERNS DESCRIPTIONS OF EMOTIONAL INCIDENTS IN CHILDHOOD. THE RESPONSES SHOULD BE RATED I FOUR DIFFERENT WAYS. FIRST, THE NUMBER OF WORDS USED TO DESCRIBE EACH EXAMPLE SHOULD BE COUNTED. SECOND, THE EMOTIONAL EVENT SHOULD BE CLASSIFIED (AS ONE OF THE 7 TYPES). THIRD, THE EMOTION SHOULD BE RATED AS ‚INTENSE', /‚MODERATE'/‚MILD'/ABSENT. LAST THE EMOTION SHOULD BE CLASSIFIED AS ‚POSITIVE'/ ‚NEGATIVE' /‚NEUTRAL'

If you think of your childhood – can you tell me of an event that made you very happy?
Please describe to me how you felt.
And what it was exactly that made you feel so happy.
. . . and an event that made you feel very sad
Please describe to me how you felt.
And what it was exactly that made you feel so sad.
.. . . .and an event that made you feel very angry.
Please describe to me how you felt.
And what it was exactly that made you feel so angry
. . . and an event that made you feel very frightened
Please describe to me how you felt.

And what it was exactly that made you feel so frightend
(In case that the participant denies ever having been . . .: „ really? Nothing ever made you . . .? That's very unsusual for a child! Are you sure that there really never was something?")

G. THIS SECTION IS LINKING PATTER. RATE AS PER SECTION B.

Puberty, Adolecsence, Young Adulthood

When, would you say, did puberty start ? What happened then?
How did the relationships to Mom/Dad develope? Were there any changes? Did anything change in your relationships to your siblings? Were there any changes in your situation at home? (people moving in out, siblings leaving family, grandparents dying etc.) How were those changes for you?
Were there any changes in your situation at school? How about your friends in and outside of school? Did former friends stepp out of your life, did you form new friendships?
How wa your academic performance at school developing in the years after puberty has started? Did yor attitude towards school and family change?
How did you get on with the teachers?
I just wondered whether you remeber your first period. When was that? How did it happen? Did you understand what was happening? Has anyone told you before about girls having periodic bleeds? Were there any reactions to your first period in your family? What did your mother say or do?
Do you remember how you felt about your body starting to change? Were you among the first in your surrounding to hav these changes or were you late with them compared to the other youngsters?
Do you remember when you started to have an interest in the other sex? How old were you? What was the first thing that came up? Did you fall in love? Or did you find yourself seeking to be with boys/girls? Or was it rather that boys/girls were trying to be closer to you?
When did you notice sexual interest? What did you do to follow up on that interest?
Do you remeber whether you fell in love with anyone? Who was it? So what happened with that girl/guy? Was there also some physical exchange? Did you kiss? Or more? Was that when you had sex the first time? Or when did that happen and with whom?
When, would you say, did you have the first time something like a love relationship? Who was the girl/woman//boy/man?
How was this relationship?
How long did it last? Why did it end? And who ended it ?
Was there a next relationship?
Assessment of the current of relationships to others and to him/herself
When did you meet your husband/wife/current partner?
Since when are you together? When did yu get married/wh y didn't you get married?
How about the children? You said you had XXX: Didn't you want any/ How did it go with them until now?
How is your relationship to your husband/wife/partner?
How ist the relationship to your children?
How do you, now as a grown up, get on with your parents ? . . .and your parents in Law?
What happened to your friends from childhood and adolescence? Are there still part of your life? Did the friendship last or intensify even? Did you loose any of your old friends? What happened? How did that feel at thet time? . . .and today?
Did you make any new friends? How is the relationship to them today?

H. THE FOLLOWING TWO QUESTIONS ARE RATED AS ‚YES' /‚NO' RESPONSES.

Do you have lots of fun in your life? Tell me more about that?
Does it happen to you that you sometimes feel really lonely? How does that happen? And how do you feel than?

I. THIS SECTION CONCERNS CURRENT EMOTIONS IN COMPARISON TO OTHER ADULTS. THE RESPONSES ARE TO BE RATED IN THE SAME WAY AS SECTION D.

Are you often happy? How does it come about that you get to feel really happy?
Like before i'd like you to try and compare yourself to others. Do you think, that you're more often happy than others? Or is it rather that you are less often happy? Or is it about the same?
What about feeling sad? How does it come about that you start feeling really sad?
And in comparison to others – Are you more often sad/less often sad/ the same sad as anyone else?
How abou feeling angry ? How does it come about that you start feeling really angry?
And in comparison to others – Are you more often angry/less often angry/ the same angry as anyone else?
And feeling frightened? . . . . . ? How does it come about that you start feeling really frightened?
And in comparison to others – Are you more often frightened /less often frightened / the same frightened as anyone else**?**

J. THIS SECTION CONCERNS THE PARTICIPANTS OWN RANKING OF THEIR PREDOMINANT ADULT EMOTIONS. THE RESPONSES SHOULD BE RATED IN THE SAME WAY AS SECTION E.

If you think of the feelings described by these four words – which of these feelings do you experience most nowadays – and second most? . . .third...fourth.

K. THIS IS A VERY IMPORTANT SECTION. IT CONCERNS DESCRIPTIONS OF EMOTIONAL INCIDENTS IN ADULTHOOD. THE RESPONSES SHOULD BE RATED IN THE SAME WAY AS SECTION F.

Could you give me the most recent example of an event, which made you very happy. What happened? How did this come about? So how did you feel when this happened? I wonder what exactly that was that made you feel so happy?
Could you give me the most recent example of an event, which made you very sad. What happened? How did this come about? So how did you feel when this happened? I wonder what exactly that was that made you feel so sad?
Could you give me the most recent example of an event, which made you very frightened. What happened? How did this come about? So how did you feel when this happened? I wonder what exactly that was that made you feel so frightened?
Could you give me the most recent example of an event, which made you very angry. What happened? How did this come about? So how did you feel when this happened? I wonder what exactly that was that made you feel so angry?

L. THIS SECTION CONCERNS THE PARTICPANT'S SENSE OF HOW OTHERS SEE HIM OR HER VERSUS HOW HE/SHE SEES HIM/HERSELF. THE TWO ANSWERS SHOULD EACH BE CLASSIFIED IN TERMS OF ‚BEST FIT' TO ONE OF THE 7 EMOTION CATEGORIES.

How do you think people would describe you as a person?
How would you describe yourself as a person?

M. THIS SECTION CONCERNS TRUST. THE ANSWER TO THE FIRST QUESTIONS SHOULD BE RATED AS ‚YES'/‚NO' AND TO THE SECOND QUESTION ‚MORE'/‚LESS'/‚SAME'

Do you place your trust in other people easily (could you describe that to me) And if you would have to compare yourself to others, would you say you trust more/ less/ the same as others?

N. THIS SECTION CONCERNS PERSONAL SPACE BOUNDARIES. THE ANSWER SHOULD BE RATED ‚YES'/ ‚NO' NEED FOR SUCH PERSONAL SPACE BOUNDARIES ; AND ANY THEN THE CHANGE FROM WHEN THEY WERE YOUNGER MUST BE RATED ‚MORE NOW'/ ‚LESS NOW'/ ‚UNCHANGED'.

Some people have a strong sense of someting like a personal space. They easily feel uncomfortable if other people come close to them. I mean in terms of real physical closeness. They need physically their distance between themselves and other people. Of course it's not the same with everyone – family and friends can come closer, but somehow they need a space around themselves where noone should intrude. And if it happens that some one comes too close, they would very sensitively perceive that as an intrusion or an act of agression and would be very uncomfortbale or upset with that.
I wonder whether and how you experience this kind of personal space and how sensitive you are in this respect and whether you also experience such unpleasant intrusions. Could you please describe how you are in this respect.
Would you say that you are rather sensitive or rather less sensitive in this respect ? Did that change in your life? Was that different when you were younger?

O. THIS SECTION CONCERNS DEPRESSION. THIS IS A ‚YES'/ ‚NO' QUESTION, FOLLOWED BY A ‚NEVER'/‚MILD'/'MODERATE'/'SEVERE' QUESTION.

Do you currently or have you ever suffered from depression?
Please classify yourself in relatiom to feeling depressed. Do you ever/ sometimes/ most of the time feel depressed?

Appendix E
Additional Results of Data Analysis

Table 2

Comparison of Overall Experience of Anger/Fear versus Other Emotions

	Group			
	UWD (*n*=8)		CON (n=8)	
Type of Emotion	Childhood	Adulthood	Childhood	Adulthood
Anger/Fear	5.25 (1.58)	4.25 (1.16)	4.38 (1.19)	5.25 (2.05)
Other	5.50 (1.51)	6.50 (.53)	6.00 (1.07)	7.13 (.64)

Note: Means presented with standard deviation in parentheses.

Table 4

Summary of Factorial ANOVA results for Word-Count of Happy Events

Variable	***SS***	***df***	***MS***	***F***	***p***	n^2
Group Membership	92020.5	1	92020.5	4.24	.049	.13
Time of Event	9800	1	9800	.45	.507	.02
Group Membership* Time of Event	684	1	684	.03	.860	.001
Error	607277	28	21688.5			
Total	709782	31				

Table 5

Summary of Factorial ANOVA results for Word-Count of Sad Events

Variable	***SS***	***df***	***MS***	***F***	***p***	n^2
Group Membership	166176	1	166176	5.2	.030	.16
Time of Event	32385.1	1	32385.1	1.01	.323	.04
Group Membership* Time of Event	4140.5	1	4140.5	.13	.722	.005
Error	895320	28	31975.7			
Total	1098022	31				

Table 6

Summary of Factorial ANOVA results for Word-Count of Angry Events

Variable	***SS***	***df***	***MS***	***F***	***p***	n^2
Group Membership	4005.13	1	4005.13	.50	.485	.02
Time of Event	19503.13	1	19503.13	2.43	.130	.08
Group Membership*						
Time of Event	10224.5	1	10224.5	1.28	.268	.04
Error	224365.3	28	8013.04			
Total	258098	31				

Table 7

Summary of Factorial ANOVA results for Word-Count of Fearful Events

Variable	***SS***	***df***	***MS***	***F***	***p***	n^2
Group Membership	34914	1	34914	3.95	.057	.12
Time of Event	157.53	1	157.53	.02	.895	.001
Group Membership*						
Time of Event	4975.03	1	4975.03	.56	.460	.02
Error	247570	28	8841.79			
Total	287617	31				

Table 8

Intensity Ratings of Recalled Emotional Events

	Group					
	UWD (*n*=8)			CON (*n*=8)		
Event Type	Childhood	Adulthood	*MD*	Childhood	Adulthood	*MD*
Happy	2.13 (.35)	2.13 (.35)	0	2.25 (1.04)	2.38 (.74)	.13
Sad	1.62 (1.30)	2.38 (.74)	.75	2.50 (.76)	2.38 (1.06)	.13
Angry	1.12 (.99)	1.38 (.74)	.25	1.00 (1.20)	.88 (.83)	.13
Fearful	1.50 (1.31)	1.38 (1.06)	.13	1.88 (1.13)	1.38 (1.30)	.50

Note: Means presented with standard deviations in parentheses.

Appendix F
Interview with UWD Participant (ID = 10) and CON Participant (ID = 34)

Angry Event in Adulthood

Interviewer: *Iets wat gebeur het wat u baie kwaad gemaak het nou onlangs?*

CON (10): *Ons raak mos nou maar so kwaad vir alles en dan maak jy jou op die einde van die dag net self siek. Nou, wat ek nou kwaad oor is en wat ek mos nou met die man ook al gepraat het is hierdie wit huisietjie wat hierso staan, nou 'n weduwee bly mos maar 'n teiken.*
'n Weduwee bly mos maar 'n teiken en ek het al gesê wat sien die mense aan my? Sien hulle dan nie die plooie raak nie (lag)? Dan sê hulle nee, watse plooie. Nou die vrou, toe't ek mos hier op 'n keer, toe sê hulle mos nee ek moet, toe wil ek mos nou daar baklei. Nou sy sertifiseer toe mos nou ek en sy man het 'n ding aan en ek en sy man was nou, sy sy ma en pa bly hier onder. Nou, nou hulle het ook mos nou 'n Mandela-huisietjie gekry, nou staan die oud sinkhuis agter in die yard*, maar daar is nog die kinders wat nou al getrou het se meubels staan ook nog daar in daai sinkhuis. En die oupa loop met die sleutel aan sy broek se dinges. Loop hy met die sleutel. Jy kan nie daar ingaan nie, daai grootmense is nog die regte grootmense, maar sy sertifiseer mos nou. Ek en die dié vrou, ek en dié man het daar in die sandjies loop kwaad gedoen. Toe't ek mos nou na sy man geloop en aan die man gesê jy moet met jou vrou praat, want ek wil jou vrou doodslaan en ek is Rooms, so ek sal verkies, ek weet nie watter kerk julle is nie, hierdie saak maak ek 'n kerkraad saak, want ek sal my nie onskuldig so laat skuldig, laat skuldig bevind nie en ek het hulle omgedraai en gesê is dit nodig dat ek moet hierdie met hierdie kleinkind van my sweer en gesê die Here kan hierdie pikkewyntjie, ons sê mos pikkewyntjie, hierdie pikkewyntjie kan die Here wegvat as as, sover as dit nie die waarheid is nie en van die aarde af tot in die hemel. Waar ken ek daardie, daardie sinkhuisie binnekant en waar ken ek die vrou se man? Dis mos nie lekker om 'n mens onskuldig so te beskuldig omdat jy 'n weduwee is nie en hier moet 'n mens moet vir HIV-goed so bang wees.*
Ja. Nee, ek het gesê ek wil nie eens meer weet of ek 'n vroumens is nie.

Interviewer: *Vertel my asseblief van die mees onlangse situasie waar jy kwaad gevoel het.*

UWD (34): *(lang stilte) Die rede hoekom ek so kwaad was, ek het hierdie man aangekla vir onderhoud en dit is seker nou al 3 jaar en die mense het nog nie vir hom, ek meen by die hof laat uitgekom nie en dis wat my baie ongelukkig en kwaad maak, omdat hulle hulle se werk so stadig doen, want dis al 3 jaar.*

Appendix G

Interview with UWD Participant (ID = 7) and CON Participant (ID = 4)

Angry Emotional Event in Adulthood.

Interviewer: *Vertel my asseblief van die mees onlangse situasie waar jy kwaad gevoel het. Neem jou tyd.*

UWD (7): *Ek raak maar elke dag so 'n bietjie kwaad vir my mense of ek raak maar net kwaad by die huis.*

Interviewer: *Vertel asseblief vir my van die mees onlangse situasie waar jy kwaad gevoel het.*

CON (4): *Dis seker ook maar net daar waar nie, ek in 'n situasie waar ek nou kwaad was nou weer in my meisikind wat nie, sy haar Junie-eksamen was ek verskriklik teleurgesteld in en toe ek nou na die skool toe gaan om 'n bietjie te praat met die onderwysers, toe moes ek uitvind dat sy 'n baie goeie, groot taak wat sy mos toe nou nie gedoen het en ook nie ingegee het nie en ek was verskriklik kwaad, want sy hoef mos nie alleen gesukkel het nie, ek het haar nog al die jare gehelp met haar take en ek was baie kwaad gewees.*

PLAGIARISM DECLARATION

1. I know that plagiarism is wrong. Plagiarism is to use another's work and to pretend that it is one's own.

2. I have used the American Psychological Association (APA) as the convention for citation and referencing. Each significant contribution to, and quotation in, this essay/ report/ project from the work, or works, of other people has been attributed, and has been cited and referenced.

3. This essay/ report/ project is my own work.

4. I have not allowed, and will not allow, anyone to copy my work with the intention of passing it off as his or her own work.

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SIGNATURE:

DATE: 26 October 2011
STUDENT NUMBER: PTRYVO002