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An examination of the cognitive, affective, and physiological aspects of alexithymia

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AN EXAMINATION OF THE COGNITIVE, AFFECTIVE, AND PHYSIOLOGICAL

ASPECTS OF ALEXITHYMIA

by

Sabrina Freund

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An Examination of the Cognitive, Affective, and Physiological
Aspects of Alexithymia

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Abstract

The present study investigates the cognitive, affective, and physiological aspects of alexithymia. Verbal fluency measures (phonemic, semantic, Emotion Word Fluency Test; EWFT) were administered to 103 undergraduate students. Heart rate and skin conductance were measured during two baseline periods and during the administration of the performance measures. In a subset of participants ($N = 53$), additional measures of heart rate variability (HRV) and blood pressure were taken. Physiological arousal during a recovery period that followed the verbal fluency tasks was also measured in this subset. Degree of alexithymic traits in these participants was measured using the TAS-20. Due to the high comorbitidy between alexithymia and depression, the BDI-II was administered and used as a covariate in the analyses. The hypothesis was that alexithymia would be associated with the verbal fluency measures and the physiological measures. The association with verbal fluency measures was expected to be negative, with a particularly strong negative relationship between alexithymia and the EWFT. Analyses failed to find any significant associations between alexithymia and any of the performance measures or physiological measures. Further exploratory analyses revealed significant differences in heart rate and skin conductance, but not blood pressure, across the baseline periods and performance measures. These changes did not interact significantly with high or low alexithymic group membership. The implications of these findings are discussed.

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List of Abbreviations

TAS-20	Twenty-Item Toronto Alexithymia Scale
DDF	Difficulty Describing Feelings
DIF	Difficulty Identifying Feelings
EOT	Externally Oriented Thinking
BDI-II	Beck Depression Inventory – II
NSSCRs	Nonspecific Skin Conductance Responses
HRV	Heart Rate Variability

Introduction

"Alexithymia" has its roots in the term originally used by Sifneos in the 1970s. Sifneos (1973) observed a marked difficulty in distinguishing, identifying, and expressing emotions among many of his psychosomatic patients. As a personality construct, alexithymia was first defined as consisting of five distinct factors: (1) a difficulty identifying feelings, (2) a difficulty describing feelings, (3) a difficulty distinguishing between feelings and bodily sensations of arousal, (4) a poor fantasy life, and (5) an externally oriented cognitive style (Sifneos, 1973). Also during the 1960s and 1970s, similar patterns of characteristics were observed in patients with eating disorders (Bruch, 1973), posttraumatic stress disorder (PTSD), and substance use disorders (Krystal, 1968), suggesting that this construct was not limited solely to individuals with psychosomatic disorders. Since the 1970s, some psychologists have suggested that alexithymia and other personality traits are not distinct constructs, but rather are subsumed by the five major personality traits (Taylor, 2004). Luminet, Bagby, Wagner, Taylor, and Parker (1999) investigated this hypothesis and found that, when comparing a common measure of alexithymia with a big-five personality questionnaire (NEO), alexithymia was represented by a cluster of traits across the personality dimensions, supporting the idea that alexithymia is a unique personality trait. Alexithymia has been conceptualized in a number of ways over the last 40 years. It has been viewed by many as a disorder of emotion regulation, in which alexithymics are more likely to use negative adaptive behaviours, such as bingeing, in place of more adaptive alternatives, such as talking to a trusted companion (Taylor, 2004). In addition to emotion dysregulation, further research identified deficits in the cognitive processing of emotions and emotion-laden stimuli (Taylor, 2000). Alexithymia has also been associated with an inability to

represent emotions symbolically; this view holds that alexithymia is not only a lack of words for emotions, but also a lack of symbolic representation for somatic sensations in general (Bucci, 1997). Furthermore, psychologists have been in debate as to whether alexithymia represents a stable personality trait or a state-dependent phenomenon. Since the introduction of the term, research has examined a number of physiological correlates of alexithymia (Nemiah, Sifneos, & Apfel-Savitz, 1977). Consistent, however, has remained the general definition of alexithymia as a difficulty in describing and identifying feelings with an externally oriented thinking style.

From the recognition of this cluster of symptoms in the 1970s, psychologists have recognized that alexithymia puts individuals at risk for a number of health and psychological disorders (Taylor, Parker, & Bagby, 1990; Shipko, Alvarez, & Noviello, 1983; Wood & Williams, 2007). Furthermore, alexithymia is often associated with poorer therapy outcome (Ogrodniczuk, Piper, & Joyce, 2005), possibly due to an inability of these individuals to understand and explore their own feelings. A deeper understanding of alexithymia will aid in the development of more effective treatments for patients presenting with comorbid alexithymia.

Demographics and Measurement of Alexithymia

A number of measures attempting to quantify alexithymia have been developed throughout the past 40 years (Taylor, 2004). The first of these measures was the clinician-administered Beth Israel Psychosomatic Questionnaire (BIQ; Sifneos, 1973). A number of self-report measures have been developed subsequently, most notably the Bermond-Vorst Questionnaire (BVQ; Bermond & Vorst, 1998), the Toronto Alexithymia Scale (TAS; Taylor, Ryan, & Bagby, 1986), and its revision, the Twenty Item Toronto-Alexithymia Scale (TAS-20; Bagby, Taylor, & Parker, 1994). In addition, a number of studies have used dimensions derived from the Minnesota Multiphasic Personality Inventory (MMPI) to classify individuals as

alexithymic, while others have attempted to use the Levels of Awareness Scale (LEAS) in order to achieve the same goal (Lesser, 1981; Lane, Sechrest, Reidel, & Weldon, 1996). Rating scales, such as the Observer Alexithymia Scale (OAS; Haviland, Warren, & Riggs, 2000), have also been developed so that other individuals who know the person well can rate the person on a number of items to determine whether or not they may have alexithymia.

The most commonly used measure of assessing alexithymia at the current time is the TAS-20, which was created in response to shortcomings of the original TAS. This measure has demonstrated good internal consistency, test-retest reliability, and a three factor structure that is congruent with theories concerning the construct (Taylor, Bagby, Ryan, & Parker, 1990). This measure also has shown good stability and replicability in both clinical and nonclinical samples (Loas et al., 2001). It has been translated into numerous languages, including German, Chinese, and Swedish. This twenty-item self-report questionnaire consists of statements that individuals rate on a 5-point Likert scale from "strongly disagree" to "strongly agree".

A number of factor analytic studies using the TAS-20 have suggested three main factors in the alexithymia construct: a Difficulty Identifying Feelings and distinguishing them from bodily sensations (DIF), a Difficulty in Describing Feelings (DDF), and an Externally Oriented style of Thinking (EOT) (Parker et al, 1993). The first two factors have been found to be more central to the construct than the third across a range of studies. Specifically, some studies examining the factor structure of the TAS-20 have found that EOT items do not reach acceptable levels of reliability (Muller, Buhner, & Ellgring, 2003), while others found that externally oriented thinking was unrelated to affective reactivity (Pollatos, Schubo, Herbert, Matthias, & Schandry, 2008). In a study of depression and alexithymia in an older population, the TAS-20

total score, DIF, and DDF factors were correlated with depression, but the EOT factor was not (Balmonti et al., 2010).

The temporal stability of alexithymia has been debated. Some have suggested that alexithymia is a state-dependent factor that occurs in reaction to psychological distress (Honkalampi, Hintikka, Laukkanen, Lehtonen, & Viinamaki, 2001), while others maintain it is a stable personality trait (Salminen, Saarijärvi, Toikka, & Äärelä, 2006). Still others have suggested that it is possible that alexithymia may present as either a personality trait or as a state-dependent phenomenon (Taylor, Bagby, & Parker, 1997, p. 37). These researchers have differentiated between primary and secondary alexithymia, where primary alexithymia refers to a stable personality trait and secondary alexithymia refers to a reaction to psychological distress. This differentiation may potentially reflect different causal pathways and suggest that there are a number of ways that this phenomenon can manifest itself. However, the general consensus, supported by the high test-retest reliability of the TAS-20, is that alexithymia is a stable trait.

Alexithymia has been found to have a prevalence rate of about 10% in the general population (Taylor, Bagby, & Parker, 1997). A study of a Finnish population also found that this trait may be more prevalent in men than women, but that these differences were restricted to difficulties in describing feelings and an externally oriented thinking style; there were no differences between the genders in terms of identifying feelings (Salminen, Saarijarvi, Aarela, Toika, & Kauhanen, 1999). Research suggests that traumatic brain injury (TBI) increases the risk of alexithymia. A study investigating the prevalence of alexithymia following TBI found that TBI patients showed greater levels of alexithymia in comparison to demographically matched controls (Henry, Phillips, Crawford, Theodorou, & Summers, 2006). In a different population of 135 patients from a family practice residency facility, individuals with a history of

head injury were significantly more likely to exhibit alexithymic traits (Williams, Galas, Light, & Pepper, 2001).

Alexithymia is thought to put individuals at risk for a number of health and psychological illnesses, including hypertension (Taylor, 2006), substance use disorders (Taylor, Parker, & Bagby, 1990), posttraumatic stress disorder (Shipko, Alvarez, & Noviello, 1983), and anxiety disorders (Wood & Williams, 2007). Among other disorders, it has been shown to have an especially high comorbidity with depression (Honkalampi, Hintikka, Laukkanen, Lehtonen, & Viinamaki, 2001). With the high association between alexithymia and depression in the general population, depression must be taken into account as a confounding factor whenever studying alexithymia.

A single causal pathway for the development of alexithymia has not yet been identified. In fact, a variety of possible genetic and environmental factors have been proposed (Picardi et al., 2011). In a meta-analysis of the research on the biological causes of alexithymia, evidence to support a number of neurological abnormalities, including disturbance of the right hemisphere, dysfunction of the anterior cingulate cortex, frontal lobe impairment and difficulties in interhemispheric transfer, was presented (Bermond, Vorst, & Moormann, 2006). With numerous potential causal pathways to alexithymia, it seems plausible that alexithymia could be broken down into subtypes, each manifesting through different pathways.

Cognitive Deficits

Models of alexithymia have proposed major deficits in the cognitive processing and regulation of emotions. In addition to cognitive processes specific to affective processing, alexithymics seem to exhibit deficiencies in other core cognitive abilities, including executive functioning and verbal abilities (Koven & Thomas, 2010; Wood & Williams, 2007). Consistent

with a model of frontal lobe impairment in alexithymia, research has identified a possible executive functioning deficit in the alexithymic population. Executive functioning in this context refers to higher-order cognitive functions, such as planning, working memory, initiation and inhibition of behaviour, and goal-setting, which each rely heavily on frontal lobe functioning (Elliot, 2003). In a large sample of university students, Xiong-Zhao, Xiao-Yan, and Ying (2006) found that performance on the Wisconsin Card Sorting Test, which is often cited as the most commonly used measure of executive functioning, decreased as the degree of alexithymic traits increased. Huang, Zhu, Yao, and Zhou (2005) found a similar result among high and low scoring alexithymics in a population of male heroin addicts, suggesting that this association may be stable across both clinical and nonclinical samples. Other evidence for an executive functioning deficit in alexithymia comes from a study by Koven and Thomas (2010). These researchers used the Trait Meta-Mood Scale (TMMS) and the Mood Awareness Scale (MAS) in addition to the TAS-20 to define the alexithymia construct and subsequently found two different factors for the alexithymia construct: emotional clarity and emotional monitoring. They found that executive functioning, including set-shifting, initiation and inhibition of behaviour, working memory, and ability to plan and organize, was negatively associated with the emotional clarity factor. Koven and Thomas (2010) in turn suggested that the executive dysfunction associated with alexithymia may be due to a deficit in understanding and labelling emotions, rather than monitoring and attending to emotions. It may be that certain aspects of alexithymia, rather than the construct as a whole, are associated with executive functioning deficits. Both the Difficulty Describing Feelings and Difficulty Identifying Feelings items loaded highly on this emotional clarity factor, but the Externally Oriented Thinking factor did not, again suggesting that the first two factors of the TAS-20 are the most important conceptually.

Deficits in verbal abilities have also been identified. For example, Lamberty and Holt (1995) found moderate but consistent correlations between degree of alexithymia as measured by the TAS-20 and measures of verbal acquisition, including verbal IQ and reading ability, in a population of neurologically intact combat veterans. Wood and Williams (2007) also found that high TAS scores were associated with a deficit in verbal cognition as measured by verbal subtests (Vocabulary, Similarities, Comprehension) of the Wechsler Adult Intelligence Scale – Third Edition (WAIS-III). Deficits in verbal abilities may be consistent with a developmental model of alexithymia that cites poor verbal development as a potential causal pathway. In support of this hypothesis, Kokkonen, and colleagues (2003), studied alexithymia longitudinally and found a correlation between early speech ability and alexithymia 30 years later. Early speakers, identified as those children who could speak three or more words at the age of one year, had the lowest mean scores on the TAS-20 as adults. However, the effect sizes were small and speech delay at the age of one year does not reflect any real pathology. Nonetheless, even a small effect size is a notable correlation after a period of 30 years.

Still other studies have examined both verbal deficits and executive functioning deficits. Verbal fluency tasks are a well-validated measure of executive functioning, as they tap a number of executive functioning processes, including organization of verbal retrieval and recall, self-monitoring, and initiation. In addition, they tap verbal intelligence (Henry, Phillips, Crawford, Theodorou, & Summers, 2006). Therefore, using verbal fluency as a measure allows researchers to examine the possibility of an executive functioning deficit that is heavily reliant on verbal cognition. In addition, a meta-analysis of the literature shows that semantic and phonemic verbal fluency tasks are sensitive to depression (Henry & Crawford, 2005). With the high comorbidity between depression and alexithymia, the possibility that verbal fluency deficits are related to

alexithymia must be investigated. Although research on verbal fluency performance among alexithymics is scarce, there is some evidence that they do perform worse on this task. In a population of traumatic brain injury (TBI) patients and control subjects, Henry et al. (2006) compared low and high alexithymic individuals on their performance on a number of verbal fluency tasks, including semantic fluency, phonemic fluency, and alternating fluency. The Difficulty Identifying Emotions (DIF) factor was consistently negatively correlated with performance on all fluency measures, while the Difficulty Describing Feelings (DDF) factor and Externally Oriented Thinking (EOT) factor were not related to performance. These results were stable even after controlling for brain injury. Furthermore, Bogdanova, Diaz-Santos, and Cronin-Golomb (2010) found that in a group of asymptomatic individuals with HIV, alexithymia was associated with decreased performance on a measure of category fluency, but not phonemic fluency.

Support for a number of cognitive deficits in alexithymia is consistent with models of neurological abnormalities and dysfunction, as well as a model of poor verbal development. Frontal lobe functioning especially is critical for executive functions such as planning, inhibition, and set-shifting. Verbal cognition is also reliant on the proper functioning of the brain. Also important to consider are models of symbolic language dysfunction in alexithymia since an inability to create a symbolic representation of affect in alexithymia may stem from poor verbal abilities in general.

Emotion-processing Deficits

Deficits in the cognitive processing of emotions are though to be at the core of alexithymia (Taylor, 2000). However, there is debate as to the mechanism of these deficits. Proponents of an emotion-processing deficit suggest that alexithymics have a limited capacity for

processing affective stimuli, while proponents of an emotional hypersensitivity suggest that deficits arise from a hypersensitivity to emotion information. In many cases, a similar pattern of results can be explained using either of these theories. Emotion-processing abilities in alexithymia have been examined using a variety of techniques, methodologies, and paradigms. For example, studies have investigated the ability of high alexithymics to judge the valence of emotionally-laden stimuli, to accurately recognize both verbal and nonverbal affective information, and to describe their own emotional reactions (Gong & Gong, 2008; Roedema & Simons, 1999).

Consistent with a difficulty identifying feelings and distinguishing them from bodily sensations in alexithymia, a number of studies have found deficits in the recognition of emotions among high alexithymic individuals. However, the evidence is unclear as to whether this deficit is general to both verbal and nonverbal stimuli or whether it may be specific to verbal information. For example, Gong and Gong (2008) assessed the possibility of verbal and nonverbal deficits of emotion in alexithymia and found evidence for a verbal specific deficit. He found that individuals high in alexithymia using the TAS-20 responded significantly slower than individuals low in alexithymia when judging the valence of emotion words, but performed comparably when judging the valence of emotion pictures. This suggests that the deficits in alexithymia for processing affective information are limited to verbal information. In addition, Gong and Gong (2008) found that alexithymia was related to a difficulty in linking verbal and nonverbal schemes of emotion. In this phase of the experiment, participants were required to decide whether the valence of word-picture combinations was consistent or inconsistent. More evidence for a verbal deficit comes from research using a Levels of Processing (LOP) paradigm. Within this paradigm, it is suggested that our ability to remember material depends in part on the

type of analysis we use. Information can be analyzed using a shallow or perceptual approach, in which the focus is on physical characteristic of the stimulus (e.g. size, shape, colour). It can also be analyzed using a deep or conceptual approach, in which the focus is on the meaning of the stimulus (e.g. adequacy of a word in a sentence). Research consistently demonstrates better recall with a deep level of processing (Luminet et al., 2006). Luminet et al. (2006) found that high alexithymics recalled fewer emotion words, regardless of whether the words were processed at a perceptual or conceptual level. This may suggest that alexithymic individuals have a harder time processing the emotional valence of words and therefore do not perceive emotion words as more conceptually salient than non-emotion words. An alternative interpretation using a model of hypersensitivity is that the affective features of the words are distracting, causing alexithymic individuals to recall fewer words.   High alexithymics may also have a more limited affective vocabulary. For example, Roedema and Simons (1999) presented participants with a number of emotion-eliciting slides and then asked them to describe their emotional reactions. Participants with higher TAS-20 scores generated fewer emotion-related words than did participants with lower scores. These findings of impaired verbal descriptions of their emotional states are consistent with earlier findings of verbal deficits. However, it is unclear whether this impaired performance is a result of an emotional processing problem, a verbal problem, or an interaction of the two.

On the other hand, Lane et al. (1996) found that individuals high in alexithymia were impaired in their ability to recognize both verbal and nonverbal emotional stimuli. Using the Perception of Affect Task (PAT), they found that high alexithymic individuals exhibited lower accuracy rates across the subtasks (verbal-verbal, nonverbal-nonverbal, verbal-nonverbal, nonverbal-verbal). The authors suggested therefore, that the difficulty putting emotions into

words seen in alexithymia may reflect a more general impairment in the processing of any kind of emotional information. Yi et al. (2009) also used nonverbal material to examine the emotion processing deficits of alexithymics. They asked alexithymics and non-alexithymics to rate 120 affective pictures on dimensions of valence, arousal, and dominance. The alexithymic group found both negative and positive affective pictures to be less arousing than the non-alexithymic group. When looking at valence ratings, alexithymics gave lower scores to positive pictures, but higher scores to negative pictures, suggesting that emotion-processing deficits may appear different depending on whether positive or negative affective stimuli are used. Other evidence for a nonverbal deficit can be found in Parker, Taylor and Bagby's (1993) study that found high alexithymics had a harder time both producing and recognizing facial expressions. In a population of medical center employees, Mann, Wise, Trinidad, and Kohanski (1994) found a similar association between alexithymia and accuracy in the recognition of facial expressions. These difficulties specifically are in keeping with a model of right hemisphere dysfunction, as right hemisphere areas are thought to be particularly important in the recognition of facial expressions (Jessimer & Markham, 1997). Furthermore, McDonald and Prkachin (1990) found that high alexithymic participants exhibited a deficit in spontaneous displays of negative affect and had difficulties in posing the emotions of happiness and anger. Emotion processing difficulties in alexithymia, thus, may reflect a more general impairment, rather than one specific to verbal information.

Other studies investigating the reactions of alexithymic individuals to emotional stimuli have employed a number of paradigms, including affective priming, signal-detection, and Stroop effects (Suslow, 1998; Parker, Prkachin, & Prkachin, 2005; Parker, Taylor, & Bagby,1993). In line with opposing theories of emotion processing deficits in alexithymia, there seem to be

contradicting results within these studies. The affective priming paradigm is based on the observation that individuals take less time to respond to stimuli when they are primed with emotionally-congruent stimuli (Hermans, De Houwer, & Eelen, 1994). Suslow (1998) found that the Difficulty Describing Feelings factor was associated with affective facilitation for negative stimuli, but that the Externally Oriented Thinking factor and the sum TAS-20 score were associated with affective facilitation for positive stimuli. This again suggests that patterns of deficits may vary depending on the use of negative or positive information. In a more recent study, Suslow and Junghanns (2002) again used a priming paradigm and a subsequent lexical decision task (i.e. classifying a string of letters as a "word" or "nonword") to examine the facilitation effects of priming an emotion word with a congruent emotion situation. High alexithymics performed worse, taking longer to make lexical decisions when primed with an emotion situation. The differences between these two studies may reflect differences in methodology, as the earlier study used emotion words, rather than situations, as primes.

Within a signal detection paradigm, Parker et al. (2005) instructed participants to respond to faces that depicted emotions, but not to respond to neutral faces. They examined the ability of alexithymics to judge negative and neutral facial expressions under slow and rapid conditions of presentation. They found that the Difficulty Describing Feelings factor of the construct was associated with a poorer ability to detect expressions of negative emotions, but only in a speeded condition. This study, however, failed to use positive expressions as a stimulus-group, which could have provided useful information as to the specificity of this emotion processing deficit.

Research examining the emotion-processing characteristics of alexithymic individuals using the Stroop task has also been inconsistent. The Stroop effect refers to the phenomenon of people taking longer to name the colour of the ink a word is printed in when the word itself is

distracting, for example when the word spells the name of an incongruent colour or spells an arousing word (Stroop, 1938). If alexithymic individuals experience difficulties processing emotional stimuli, they should be less distracted by emotion words. If, however, they experience heightened sensitivity to emotional stimuli, they should be more distracted and therefore be slower in colour-naming these words. The results found using this paradigm are inconsistent, resulting partly from the different stimuli used across these studies. Using a modified Stroop task consisting of baseline stimuli, neutral words, and arousing words, Parker et al. (1993) assessed emotion-processing capacities among low and high alexithymic undergraduate students. In line with the idea that arousing words are more distracting than neutral words, both groups took longer to colour-name this category of words. In addition, high alexithymics took longer to colour-name arousal words than did low alexithymics, but performed comparably on the other two conditions. Unfortunately, this study used arousing words, such as "rape" as opposed to emotion words specifically. While this may provide evidence that alexithymics react differently to words that are more highly arousing, it does not indicate how alexithymics respond to words with emotional connotation that are not necessarily highly arousing (e.g. "calm"). Lundh and Simonsson-Sarnecki (2002) instead used neutral, negative, and illness-words as stimuli and found that high-alexithymics were more distracted by illness-words than both the neutral and negative words. These two studies lend evidence to a model in which alexithymics are more perceptually aware of and distracted by emotion information. However, Mueller, Alpers, and Reim (2006) used positive, negative, neutral, and body-symptom words and found the opposite result. Individuals high in alexithymia were less distracted by the task-irrelevant properties of the emotion and body-symptom words than were individuals low in alexithymia. This study lends support to a model in which alexithymics have difficulties in processing emotional

information and are subsequently slower in identifying emotion stimuli. It is important to keep in mind, however, that this study used an observer-rated measure of alexithymia instead of the traditional self-report. When examining the stimulus words carefully across studies, it seems that high alexithymics were slower in colour-naming words that were highly arousing, such as the arousing words and the illness words, whereas they were faster to colour-name negative words that were not highly arousing, such as the negative emotion words and the body-symptom words. This may suggest that deficits in processing affective words disappear once the arousal of the word reaches a certain threshold. Alternatively, it could suggest that alexithymics are hypersensitive only to emotion words that are highly arousing.

Research on emotional processing in alexithymia demonstrates a number of deficits in the recognition of emotions and the reactions to certain emotional stimuli. However, it remains unclear whether the differential emotion-processing of alexithymics reflects a real deficit in this area or whether they are perceptually hypersensitive to emotional information. A difficulty in making this distinction is that both possibilities can present with the same pattern of results. If they are hypersensitive to emotional information, they may still present with a pattern of deficits in emotion-processing due to the fact that they are distracted by the affective properties of the information.

Physiological Arousal

A large body of research has been dedicated to the investigation of a possible role of the autonomic nervous system in the development of alexithymia. The autonomic nervous system is the branch of the peripheral nervous system that is involuntary and controls a number of visceral functions, including heart rate and perspiration (Blumenfeld, 2010, p.23). It is divided into two subsystems, the sympathetic and parasympathetic, which work in conjunction to arouse and calm

the body when appropriate. As early as the 1970s, studies have found evidence for a deviation from normal autonomic nervous system arousal in alexithymia (Nemiah et al., 1977). Unfortunately, the evidence is inconsistent and far from clear. There have been two competing models of alexithymia in the literature in terms of autonomic arousal: the hypoarousal theory and the hyperarousal theory. The hyperarousal theory posits that alexithymia is related to higher tonic levels of sympathetic activity and sympathetic reactivity (or possibly parasympathetic withdrawal) to emotional stress, whereas the hypoarousal theory posits that alexithymia is related to lower levels of sympathetic activity and reactivity to emotional information (Neumann, Sollers, Thayer, & Waldstein, 2004). Using a number of different methodologies and indicators of autonomic arousal, evidence has been found for both of these models, as well as for a model of no differences. In addition, if there are differences between low and high alexithymics in terms of their autonomic arousal, it remains unclear whether these differences represent a difference at baseline or whether they reflect differences in reactivity. Differences in autonomic arousal found by different studies may also reflect the different measures used to identify alexithymia as well as different tasks used to induce stress.

A number of physiological measures have been used in the investigation of the autonomic deviation found in alexithymia. The use of electrodermal activity as an indication of sympathetic autonomic arousal is common in a number of studies on alexithymia (Franz, Schaefer, & Schneider, 2003). Heart rate and heart rate variability have also been used frequently in the study of alexithymia (Wehmer, Brejnak, Lumley, & Stettner, 1995; Neumann et al., 2004). Although resting and reactive blood pressure have not been found to differentiate between low and high alexithymics in some studies (Linden, Lenz, & Stossel, 1996), it continues to be a widely used variable in the alexithymia literature.

Based on the hypoarousal hypothesis, one would predict that individuals high in alexithymia will exhibit less physiological activation than individuals low in alexithymic traits when facing similar emotion-laden conditions. Evidence for this theory comes from a number of studies, using a variety of tasks that impose either cognitive or emotional demands. Linden, Lenz, and Stossel (1996), using both heart rate and blood pressure measurements, examined physiological activation in response to an isometric hand grip task, mental arithmetic task, and a high negative-affect social interaction task. Across all three of these tasks, which reflect physically, cognitively, and emotionally demanding tasks respectively, high alexithymics exhibited reduced heart rate responses, with no corresponding differences in blood pressure. In another study using the same measures of physiological arousal, Newton and Contrada (1994) found that alexithymics exhibited significantly lower mean heart rate increases when delivering a speech about their most undesirable personality characteristic, a task determined to be highly stressful. In addition, measures of heart rate variability in this study suggested blunted sympathetic activation and diminished vagal withdrawal during reactivity. Again, no differences in blood pressure were observed. Fukunishi, Sei, Morita, and Rahe (1999) found a similar result when exposing low and high alexithymics to a stressful condition. Nemiah et al. (1977) found lower levels of oxygen consumption during emotional imagery and mental arithmetic among high alexithymic men and women. Wehmer et al. (1995) exposed college students to emotion-provoking slides while their heart rate and electrodermal responses were monitored. High alexithymia was associated with less of an increase in heart rate response and fewer electrodermal responses while viewing the slides. Friedlander, Lumley, Farchione, and Doyal (1997) found that women high in alexithymic traits exhibited less heart rate change in response to viewing disgusting scenes than did women low in these traits.

The hyperarousal model of alexithymia posits that individuals high in alexithymic traits react with higher levels of autonomic activity in response to emotion-laden stimuli. Waldstein, Kauhanen, Neumann, and Katzel (2002), for example, found greater blood pressure responses in older men with high alexithymia to anger provocation. In a number of studies, alexithymics have been shown to have higher autonomic levels at rest. Across studies, alexithymics exhibited significant elevations in baseline heart rate (Wehmer et al, 1995; Fukunishi et al, 1999) as well as significantly higher electrodermal activity (Friedlander et al, 1997; Stone & Nielson, 2001). These suggest higher tonic levels of autonomic arousal, evidence for a hyperarousal model of alexithymia. Further, Neumann et al. (2004) examined blood pressure and indicators of heart rate variability following an anger recall task and found that alexithymia was associated with prolonged cardiovascular recovery.

To complicate matters further, other studies have not found any differences at baseline between low and high alexithymic individuals, in either heart rate or electrodermal activity (Linden, Lenz, & Stossel, 1996; Franz, Schaefer, & Schneider, 2003; Neumann et al., 2004). One such study cited short baseline measurements as a possible explanation for their not finding any differences. In other instances, evidence for both models are found within the same study. An interesting study by Neumann, Sollers, Thayer, and Waldstein (2004) found support for the hypoarousal theory during the reactivity stage of the experiment, an anger recall task. During the recovery phase of the experiment, the evidence was in favour of a hyperarousal theory of alexithymia since alexithymic individuals took a longer time to recover. Franz, Shaefer, and Schneider (2003) measured skin conductance response and heart rate during both a mental and emotional-load task. These tasks consisted of a continuous performance test and the viewing of video clips, respectively. During both conditions, individuals high in alexithymia exhibited

fewer spontaneous fluctuations in skin conductance per minute than individuals low in alexithymia. The results using the heart rate measurement were less clear. During the emotional load condition, individuals high in alexithymia exhibited a lower mean heart rate. During the mental load, however, they exhibited an increased heart rate. The lower electrodermal response across conditions suggests that alexithymics have lower autonomous arousal in general, but not to emotional stimuli specifically. The mixed results using heart rate may suggest that the type of task used, in this case a demanding cognitive task versus a more passive emotional task, makes a difference.

Although there is disagreement as to whether the differences exhibited by alexithymics constitute hypo- or hyperarousal, it seems clear that alexithymia is associated with some form of deviation from normal autonomic responses. It needs to be investigated more thoroughly whether these differences are present at baseline or occur in response to emotion-stimuli.

Current Study

The current study aimed to bring together the research on alexithymia in terms of corresponding emotion-processing deficits, cognitive deficits, and physiological deviations of the autonomic nervous system. The current study hoped to give a more comprehensive view of the associations between these various deficits and degree of alexithymic traits. More specifically, it aimed to add to the understanding of the nature of the verbal deficits, the emotion-processing deficits, and the autonomic nervous system deviations. In order to do so, verbal fluency measures, including both semantic and phonemic fluency, were administered. To address the association between cognitive functioning and emotional functioning, a new task of emotion word fluency was used as an additional performance measure. Heart rate and electrodermal activity were measured both at baseline and throughout all three verbal fluency tasks in order to

provide valuable information about autonomic activity at rest as well as in response to cognitively and affectively demanding tasks. In addition, blood pressure was taken at baseline, immediately following each verbal fluency task, and at the end of the recovery phase. HRV was measured during baseline and during the recovery phase in order to gain insight into the relative contributions of the sympathetic and parasympathetic divisions of the autonomic nervous system. Performance on these verbal fluency measures provided information about how alexithymic traits are associated with performance on cognitive tasks, specifically executive functioning and emotion-processing tasks. Semantic fluency and phonemic fluency tasks provided information about executive and verbal functioning within alexithymia, while the emotion word fluency task was used to assess cognitive and emotion-processing in a single task. Physiological measurements were taken to lend further evidence to either a hyperarousal or hypoarousal model of alexithymia, or to help clarify why these discrepancies exist in the literature.

It was hypothesized that these three verbal fluency tasks and four physiological measures would be associated with degree of alexithymia. Based on previous research suggesting verbal and executive functioning difficulties in alexithymia, it was hypothesized that alexithymia would be related to significantly worse performance on all three measures of verbal fluency (semantic, phonemic, and emotional). Since the emotion word fluency task purports to measure both aspects of verbal functioning and emotion processing, this task should have the strongest association with alexithymia. With the inconsistencies in physiological reactivity in alexithymia studies, these measures should have weaker associations with alexithymic traits than the verbal fluency tasks.

Method

Participants

A total of 104 participants (13 males and 91 females) were recruited through the University of Windsor undergraduate participant pool. One participant was removed from the analyses as the physiological equipment was not functioning properly. Participants ranged in age from 18 to 54 years, with a mean age of 22 years. Self-reported ethnicities included 60% Caucasian, 7% European (Italian, French), 9% Middle Eastern (Muslim, Lebanese, Arabic, Pakistani), 7% African/Black, 7% Asian, 1% First Nation, and 9% Mixed/Other. Participants ingested between 0 and 3 caffeinated beverages ($M = .93$, $SD = .90$) in the 24-hour period preceding the study. Physical activity in this same period ranged from 0 to 360 minutes ($M = 51.67$, $SD = 62.07$). Physiological arousal can be influenced by both substances ingested (Green & Suls, 1996) and by prior physical activity (Bernardi, Valle, Coco, Calciati, & Sleight, 1996).

Measures

Questionnaires

Demographics questionnaire: Participants provided basic demographic information, including age, gender, ethnicity, nationality, and education. In addition, they were asked to provide their psychiatric, neurological, and medical history. This included information about current medications.

Intake form: Participants provided information about any physical activity completed within the last 24 hours. They also indicated the amount and time of any substances ingested within the last 24 hours.

Toronto Alexithymia Scale – Twenty Items (TAS-20): The TAS-20 is the most commonly used measure of alexithymia. It is a self-report questionnaire comprised of twenty statements. Participants rate the extent to which they agree with each statement on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). Five of the items (4,5,10,18, and 19) are reverse scored.

A total score was computed by summing all twenty responses. Total scores range from 20 to 100 points. Higher scores indicate the presence of more alexithymic traits. Clinical cut-offs are also available: ≤ 51 = non-alexithymics, 52-60 = possible alexithymia, and ≥ 61 = alexithymic. In addition to a total score, the individual items also load on three factors: Difficulty Describing Feelings (DDF), Difficulty Identifying Feelings (DIF), and Externally Oriented Thinking (EOT). The score for each subscale was computed by summing the responses for that factor. The TAS-20 has demonstrated good internal consistency (Parker et al., 1993).

For the first group of participants ($n = 50$), recruitment was based on answers to screening questions. Four items were chosen from the TAS-20 due to their high factor loadings and used as a screening criterion in order to create a low alexithymia and high alexithymia group. The scores obtained on this screening questionnaire ranged from 4 to 20. Individuals scoring between 11 and 15 were excluded from participation. However, Taylor, Bagby, and Parker (1993) suggest that, despite the existence of clinical cut-offs for the TAS-20, alexithymia is a dimensional construct that should be studied as a continuous variable and the screening questions were thus removed for the second group of participants ($n = 53$).

Beck Depression Inventory – II (BDI-II; Beck, Steer, & Brown, 1996*):* The BDI-II is a common measure of depressive symptomology. It is a self-report questionnaire comprised of 21 groups of statements assessing areas of depression such as Indecisiveness, Mood, and Sense of Failure. For each group, participants choose the statement that best describes the way they have been feeling for the past two weeks. The statements are scored on a four-point scale. A total score was computed by summing all 21 responses; scores range from 0 to 63 and lower scores indicate fewer depressive symptoms. Clinical cut-offs also exist for this measure: scores of 0-13 indicate minimal depression, scores of 14-19 indicate mild depression, scores of 20-28 indicate

moderate depression, and scores of 29-63 indicate severe depression. The BDI-II has

demonstrated fairly high test-retest reliability (*r* = .72 to .91; Osman, Kopper, Barrios, Gutierrez,

& Bagge, 2004). In regards to validity, there are strong correlations (*r* = .83) with number of

depressed mood symptoms on the Structured Clinical Interview for *DSM-IV* Disorders (SCID-I;

Sprinkle, Lurie, Insko, Atkinson, & Jones, 2002).

Performance measures

Verbal Fluency ('F', 'A', 'S' + Animals; Benton, 1968; EWFT; Abeare et al., 2009):

Participants were instructed to name as many different words as they could in a one minute time

interval. The words had to meet specific criteria and follow certain rules, which varied by the

task. For both the phonemic and semantic trials of the FAS, test-retest reliability has been found

to be quite high (over *r* = .70; Basso, Bornstein, & Lang, 1999). Validity is also high for the

FAS, as it correlates highly (*r* = .87 to .94) with other measures of verbal fluency, such as the

Controlled Oral Word Association Task (Lacy, Gore, Pliskin & Henry, 1996). Preliminary

research suggests that the Emotion Word Fluency Task (EWFT) has good test-retest reliability (*r*

= .68 to .74; Abeare et al., In Prep). Furthermore, the EWFT demonstrates validity in its

correlation with measures of phonemic (*r* = .29) and semantic fluency (*r* = .29; Abeare et al.,

2009).

Phonemic fluency: Participants were asked to name words beginning with a certain letter

(i.e. F, A, S), with the exception of proper nouns or names, numbers, or variations of a word

already given. Rule breaks were not included in the total score. This task consisted of three

trials and the total number of non-perseverative words produced across the three trials was taken

as the phonemic fluency score.

Semantic fluency: Participants were asked to name words belonging to a certain category (i.e. animals). Non-animal words were not included in the total score. This task consisted of only one trial and the semantic fluency score was equivalent to the number of non-perseverative words produced.

Emotion word fluency: Participants were instructed to name as many different emotion words as they could in a one-minute time interval. Non-emotion words were not included in the final score. Similar to the semantic fluency task, the emotion word fluency score was equivalent to the number of non-perseverative words produced in a single trial.

Physiological measures

Physiological equipment: All physiological activity was recorded using the PowerLab system (Powerlab 8/30, AD Instruments, Colorado Springs, Colorado, USA), a data acquisition and analysis system. Transducers for varying types of physiological measures were attached to the input channels of the PowerLab hardware. Raw data acquired was then transformed into digital form before being transmitted to a computer. All channels used a sampling rate of 1000/s. Once data was sent to the computer, it was viewed using LabChart, a computer program used for the storage and analysis of this data.

Electrodermal response (galvanic skin response): Galvanic skin response (GSR) is a measure of the electrical conductance of the skin, which changes with the moisture level. Sweat glands are controlled by the autonomic nervous system, making GSR an indication of physiological arousal. Cacioppo & Tassinary (1990) suggest that skin conductance is one of the most robust physiological measures of stress and autonomic nervous system activity. GSR was measured using bipolar skin electrodes attached to participants' pointer and ring fingers. It was measured in microsiemens (μS). In this study, the number of nonspecific skin conductance

responses (NSSCRs) were measured during baseline, verbal fluency tasks, the EWFT, and, for the second group of participants, during a recovery period.

Heart rate: Heart rate was measured using a finger pulse transducer attached to the top of a participant's middle finger. The input from this transducer is displayed in millivolts (mV) and then transformed into beats per minute (bpm) using a simple conversion performed by the LabChart software. In this study, mean heart rate was examined during baseline, performance tasks, and, for the second group of participants, during a recovery period.

Heart rate variability (HRV): Aspects of HRV examined in this study were derived from the measured heart rate data and included: very low frequency (VLF), which represents harmonic noise, low frequency (LF), which represents primarily sympathetic neural oscillations of heart rate, high frequency (HF), which represents vagal modulation of heart rate, and total power (TP), which represents the complete power of the harmonic spectrum. It also examined the LF:HF ratio, which provides insight into the sympathovagal influences contributing to alternations in heart rate by the autonomic nervous system and the HF:TP ratio, which provides insight into the parasympathetic modulation of heart rate (Stiller-Moldovan, Kenno, & McGowan, 2012).

Blood pressure: In this study, systolic and diastolic blood pressure was measured using a blood pressure monitor. For each participant, participants were in a seated position and the blood pressure cuff was placed on the upper left arm. Blood pressure was measured a total of six times, once during each baseline period, following each verbal fluency task (FAS, Animals, EWFT), and during the recovery period. For each measurement of blood pressure, the MAM average mode (automatic triple measurement) was used as a mode of measurement as it produces more reliable readings than the standard (single measurement) mode.

Procedure

In the first group of participants, participants were introduced to the physiological equipment and asked to use the washroom and wash their hands prior to signing the informed consent. After providing consent, participants were asked to complete the brief demographics questionnaire and intake form. Heart rate and skin conductance were recorded for a 3-minute baseline period, during which time participants were asked to sit quietly without moving. Following this baseline measurement, physiological equipment was removed in order to allow participants to complete the BDI-II and TAS-20 questionnaires. Critical items of the BDI-II (i.e. those assessing suicide risk) were examined immediately by the researcher. None of the participants in this study endorsed current suicidal ideation. The physiological equipment was then again attached to record heart rate and skin conductance during a 1-minute baseline that consisted of engaging in conversation with the researcher, as well as during the verbal fluency measures.

In the second group of participants, the procedure was changed slightly in order to gather additional information about blood pressure and heart rate variability. The initial baseline was extended to a period of 10-minutes, blood pressure was taken during each baseline period and after each of the verbal fluency tasks, and participants were asked to sit quietly without moving at the end of the study for a 10-minute recovery period. HRV data were collected during the 10-minute baseline and recovery periods. Following this recovery phase, a final measure of blood pressure was taken. Following completion of the study, participants were thanked for their time and assigned bonus credits.

Data Reduction

Skin conductance was measured by the number of NSSCRs that occurred during each baseline, performance measure, and recovery period. Following the procedure of Franz et al.

(2003), the number of NSSCRs were measured as any fluctuations greater than 0.1 µs. Heart rate was measured as the mean heart rate during each time period, while blood pressure included both systolic and diastolic blood pressure values. For the HRV analysis, ensemble averages of 256 beat sequences were taken from a minimum time series of 400 beats. Ectopic beats were edited and replaced by linear interpolation from adjacent cardiac cycles (Stiller-Moldovan, Kenno, & McGowan, 2012). Only those tracings that had 5% or less ectopy-corrected beats were accepted for the HRV analyses, therefore 3 participants were removed. These R-R (i.e. beat to beat) intervals were then submitted to a fast Fourier transform (FFT) to analyze HRV. FFT is a frequency domain method that provides information on the power distribution across frequencies of the HR spectrum (Malik, 1996).

Statistical Analysis

To determine whether alexithymia scores were associated with gender, an independent samples t-test was conducted. Alexithymia has been shown to be more prevalent in men and although it was anticipated that the majority of the sample would be female, it was examined as a possible covariate. To determine whether depressive symptoms would need to be used as a covariate, correlations between the BDI-II and the TAS-20 and its factor scores were examined. It was expected that there would be significant correlations and that depressive symptomology would need to be controlled for in the analyses. Two separate baselines of physiological activity were recorded in order to determine whether there were significant differences in heart rate, number of NSSCRs, or blood pressure when participants were sitting quietly in comparison to engaging in conversation with the researcher. Paired sample t-tests were conducted for all four physiological measures. It was anticipated that there would be significant differences and that both baseline measures would need to be included in the analyses.

To evaluate the hypotheses, three linear regressions were conducted using TAS-20 score as the dependent variable, BDI score as a covariate, and verbal fluency scores and physiological measures as the independent variables.

Hypothesis 1: For verbal fluency measures, individuals higher in alexithymic traits were expected to perform worse. Emotional word fluency was expected to have the strongest relationship with alexithymia score, as it purports to rely on affective abilities in addition to the cognitive abilities measured by phonemic and semantic fluency tasks. To evaluate hypothesis 1, the linear regression was conducted with TAS-20 scores as the criterion variable, BDI-II scores entered in the first block as a covariate, and scores on the FAS, Animals, and EWFT tasks entered in the second block as predictor variables. To evaluate differences between TAS-20 scores, high and low alexithymia groups were created using standardized scores of ≥1 and ≤1 respectively. A MANOVA was conducted using these two groups as the independent variable and performance on all verbal fluency measures as the dependent variables. To assess possible relationships between TAS-20 subscale scores and verbal fluency, three additional regressions were conducted using the DDF, DIF, and EOT factors as criterion variables and verbal fluency measures as predictor variables.

Hypothesis 2: Degree of alexithymic traits was expected to be associated with all of the physiological measures: heart rate, skin conductance, blood pressure, and heart rate variability. These measures were expected to be significantly associated with alexithymic traits at baseline, during the verbal fluency tasks, and during a recovery period following the performance measures. It was hypothesized that results would show either under and over-arousal of the autonomic nervous system, or both, based on these physiological measures. In order to evaluate hypothesis 2, two separate linear regressions were conducted. The first regression included

physiological measures collected for all 98 participants; it was conducted with TAS-20 scores as the criterion variable, BDI-II scores entered in the first block as a covariate, and skin conductance and heart rate measures at baseline 1 and 2 and during the tasks entered in the second block as predictor variables. The second regression included physiological measures collected for a subset of 53 participants; it was conducted with TAS-20 scores as the criterion variable, BDI-II scores entered in the first block as a covariate, and skin conductance and heart rate values during recovery, blood pressure readings at all time periods, and heart rate variability measures at the first baseline and during recovery entered in the second block as predictor variables.

To clean the data, prior to conducting analyses, skewness and kurtosis values were assessed for all predictor variables. All of the heart rate variability variables (with the exception of baseline and recovery HF:TP ratios) had unacceptable levels of skewness and kurtosis (>2) and were thus log transformed. Examination of standardized residual plots and normal probability plots revealed no indications of heteroscedasticity or non-linearity in the data. Multivariate outliers were identified using critical Mahalanobis values of $\chi(9) = 16.92$, $p < .05$, for the first group of participants and $\chi(31) = 43.77$, $p < .05$, for the second group of participants . This resulted in the removal of 5 participants, and a final sample size of 98.

Following the original analyses, further exploratory analyses were conducted to examine whether there were differences in physiological changes across time, and whether these changes interacted with alexithymia. Four repeated measures ANOVAs were conducted using extreme TAS-20 scores (identified using standard scores of ≥ 1 and ≤ -1 on the TAS-20) as the independent variable and skin conductance, heart rate, and blood pressure over the time intervals of the baseline and three verbal fluency tasks as the dependent variables.

Results

In this sample, TAS-20 scores ranged from 26 to 71 ($M = 43.52$, $SD = 9.59$). Six participants (6%) met the clinical cut-off for alexithymia. The independent samples t-test revealed no significant differences between males ($M = 48.08$, $SD = 12.01$) and females ($M = 42.98$, $SD = 8.98$) on their degree of alexithymic traits ($p = .07$). Gender was thus removed in all subsequent analyses. Scores on the BDI-II ranged from 2 to 37 ($M = 9.46$, $SD = 6.31$).Descriptive statistics for performance measures and physiological measures are presented in tables 1 and 2 respectively.

Paired samples t-tests were conducted to determine whether there was an effect of talking on the physiological measures between the two baseline periods. Heart rate was significantly lower during the first ($M = 78.01$, $SD = 12.69$) than the second ($M = 83.84$, $SD = 11.20$) baseline period [$t(2, 96) = -6.82$, $p < .001$]. The number of NSSCRs was significantly higher during the first ($M = 9.94$, $SD = 8.18$) than during the second ($M = 8.10$, $SD = 4.14$) baseline [$t(2, 96) = 13.33$, $p < .001$]. Values for heart rate and skin conductance for both baseline periods were included in main analyses. Neither systolic blood pressure nor diastolic blood pressure were significantly different between the two baseline time periods [$t(2, 49) = 1.66$, $p = .10$; $t(2, 49) = .19$, $p = .85$]. Blood pressure values for the second baseline were thus removed before conducting main analyses.

Pearson product-moment correlation coefficients were computed to assess the relationship between depressive symptoms, alexithymic traits, and physiological measures. BDI-II scores were significantly correlated with TAS-20 scores ($r = .51$, $p < .001$), the Difficulty Identifying Feelings (DIF) factor ($r = .48$, $p < .001$), and the Difficulty Describing Feelings

Table 1.
Descriptive statistics for performance measures

	Min	Max	M	SD
Phonemic fluency (FAS)	18	69	37.73	10.82
Semantic fluency (Animals)	8	35	21.97	5.05
Emotion Word Fluency Test (EWFT)	4	22	11.76	3.30

Table 2.

Means and standard deviations for physiological measures

	Baseline 1		Baseline 2		During Tasks		Recovery Period	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
NSSCRs	10.32	9.11	7.98	4.11	36.35	17.04	30.19	20.75
Heart Rate	77.92	13.06	84.20	11.23	81.79	11.15	78.96	11.06
Blood Pressure								
Systolic	118.21	10.34	117.06	11.22	118.04	11.51	113.34	10.83
Diastolic	74.32	8.713	74.13	8.88	74.91	7.50	72.72	7.91
Heart Rate Variability								
VLF	540.34	442.014					850.97	693.47
LF	427.60	400.013					578.41	455.56
HF	396.26	423.23					416.68	397.44
TP	1364.20	1079.20					1846.06	1391.90
LF:HF	1.45	.91					1.74	1.06
HF:TP	.28	.12					.23	.10

*Note. NSSCRs = nonspecific skin conductance responses; VLF = very low frequency; LF = low frequency; HF = high frequency; TP = total power; LF:HF = low frequency: high frequency; HF:TP = high frequency: total power

(DDF) factor ($r = .55$, $p < .001$), but not with the Externally Oriented Thinking (EOT) factor ($r = .18$, $p = .103$). It was thus included as a covariate in all subsequent analyses. Additional Pearson product-moment correlation coefficients were computed to assess the relationships between heart rate, skin conductance, and performance on the three verbal fluency measures. After controlling for depression, number of NSSCRs positively correlated with EWFT performance ($r = .54$, $p = .01$), but did not correlate with FAS ($r = -.07$, $p = .78$) or Animals ($r = .06$, $p = .81$). Heart rate at time of task was correlated with FAS performance ($r = -.44$, $p = .05$) and EWFT performance ($r = -.55$, $p = .01$), but not with Animal fluency performance ($r = -.20$, $p = .40$).

The first linear regression was conducted with TAS-20 scores as the criterion variable, BDI-II score entered in the first block as a covariate, and scores on the FAS, Animals, and EWFT tasks entered in the second block as predictor variables. TAS-20 total scores were significantly predicted by the overall model, adjusted $R^2 = .22$; $F(4, 93) = 7.93$, $p = .00$. However, the only significant predictor in the model was BDI-II scores ($\beta = .49$, $p = .00$). To examine the extreme groups, standard scores of ≥ 1 and ≤ -1 on the TAS-20 were coded as high and low alexithymics respectively. This new variable was then entered as an independent variable into a MANOVA with all verbal fluency measures entered as dependent variables. Using these extreme groups, there were again no significant effects, $F(3, 32) = .27$, $p = .85$. Three additional linear regressions were conducted using verbal fluency measures to predict the individual factor scores of the TAS-20. Performance on verbal fluency tasks did not significantly predict any of the TAS-20 factor scores: DDF [adjusted $R^2 = -.02$; $F(3, 94) = .38$, $p = .77$], DIF [adjusted $R^2 = -.02$; $F(3, 94) = .47$, $p = .71$], or EOT [adjusted $R^2 = -.01$; $F(3, 94) = .58$, $p = .63$].

To examine the second hypothesis, two additional linear regressions were conducted. The first was conducted with TAS-20 scores as the criterion variable, BDI-II score entered in the first block as a covariate, and measures of skin conductance and heart rate at baseline 1 and 2 and during the tasks entered in the second block as predictor variables. TAS-20 total scores were again significantly predicted by the overall model, adjusted $R^2 = .21$; $F(7, 89) = 4.62$, $p = .00$. Only BDI-II score was a significant predictor ($\beta = .48$, $p = .00$). The number of NSSCRs or mean heart rate at baseline or during performance measures did not increase the predictive power of the model. The second regression was conducted using TAS-20 scores as the criterion variable, BDI-scores as a covariate, and blood pressure at all time intervals, the number of NSSCRs during the recovery period, and pre- and post-HRV as predictor variables. This model did not significantly predict TAS-20 total scores, adjusted $R^2 = .16$; $F(18, 27) = 1.49$, $p = .17$.

Regressions conducted with the complete sample of 98 participants revealed adequate levels of power (0.88 – 0.99). Due to the large number of predictors and smaller sample size for regressions conducted with only the subset of 53 participants, power levels were inadequate (<.00) and thus these results should be considered exploratory.

Exploratory analyses using four separate repeated measures analyses were conducted using TAS-20 group as a between-subjects variable and number of NSSCRs, heart rate, systolic blood pressure, and diastolic blood pressure as dependent variables. Measures of the dependent variables at baseline, during the phonemic fluency task, the semantic fluency task, and the EWFT were used to assess changes in autonomic arousal over the course of the study. TAS-20 group was included to assess the effect of alexithymic group on any changes. Main effects were significant for NSSCRs [$F(4, 30) = 25.39$, $p = .00$], heart rate [$F(4, 30) = 4.78$, $p = .00$], but not for systolic blood pressure [$F(4, 16) = .36$, $p = .83$] or diastolic blood pressure [$F(4, 16) = .12$, p

= .98]. The number of NSSCRs decreased significantly across the first three time intervals, but the increase in NSSCRs from semantic fluency task to the EWFT was not significant. Heart rate decreased significantly between baseline and the phonemic fluency task, as well as between the semantic fluency task and the EWFT. It did not change significantly between the phonemic and semantic fluency tasks. Descriptive statistics are presented in Table 3 and post-hoc comparison results are presented in Table 4. There were no significant interactions between TAS-20 group and NSSCRs [F (4, 30) = .51, p = .73], heart rate [F (4, 30) = 1.27, p = .30], systolic blood pressure [F (4, 16) = 1.03, p = .42], or diastolic blood pressure [F (4, 16) = .86, p = .51].

Discussion

The purpose of the present study was to examine the association between alexithymia and a number of variables: cognitive abilities, emotion-processing abilities, and autonomic nervous system functioning. The hypothesis was that individuals higher in self-reported alexithymic traits would perform worse on tasks of phonemic and semantic verbal fluency, as well as on a task of emotion word production. It was predicted that performance on the emotion word fluency task would have the strongest negative association with alexithymia, as it incorporates both cognitive and emotion-processing abilities. Previous research has demonstrated deficits in various cognitive and affective processes in individuals high in alexithymia. In addition, it was expected that alexithymia would be associated with dysregulation of the autonomic nervous system. Specifically, a higher degree of alexithymic traits was predicted to be correlated with a number of physiological measures: blood pressure, heart rate (including heart rate variability), and skin conductance. It was hypothesized that these associations would be present at baseline, during the performance measures, and during a recovery period.

Table 3.

Means and standard deviations for skin conductance and heart rate repeated-measures

	M	SD
NSSCRs		
Baseline 1	8.58	8.33
Baseline 2	8.13	4.69
FAS	7.20	3.87
Animals	6.80	4.08
EWFT	7.40	4.38
Heart Rate		
Baseline 1	76.01	11.40
Baseline 2	82.85	10.20
FAS	80.96	12.05
Animals	81.41	12.37
EWFT	78.65	11.71

Table 4.

Post-hoc contrasts for skin conductance and heart rate repeated-measures

	Sum of Squares	F	P
NSSCRs			
Baseline 1 vs. Baseline 2	923.14	67.65	.00*
Baseline 2 vs. FAS	1305.98	97.48	.00*
FAS vs. Animals	572.38	68.80	.00*
Animals vs. EWFT	7.22	.85	.36
Heart Rate			
Baseline 1 vs. Baseline 2	1112.11	14.65	.00*
Baseline 2 vs. FAS	257.37	5.58	.02*
FAS vs. Animals	66.52	3.11	.09
Animals vs. EWFT	373.08	9.35	.00*

Note. *significant at the .05 level

Although the hypothesized associations between alexithymia, verbal fluency (phonemic, semantic, and emotion word fluency), and physiological arousal were not found, the findings are not inconsistent with previous findings in the alexithymia literature. In fact, the research in this area has been quite inconclusive and although a number of studies have found associations between alexithymia and a number of cognitive, affective, and physiological processes, an equal number of studies have found no differences. The present study attempted to provide a more comprehensive exploration of the various aspects of alexithymia. It adds to the knowledge base by narrowing the focus for future research examining cognition, emotion-processing, and physiological arousal in alexithymia. Specifically, the absence of difficulties on the particular tasks employed in this study can guide future studies aimed at identifying what types of cognitive and emotion-processing difficulties are associated with alexithymia.

The percentage of individuals in this university population meeting the criteria for alexithymia (>61 on TAS-20) was 6%. This is consistent with other studies estimating the prevalence of alexithymia in the normal population to be at or less than 10% (Taylor, Bagby, & Parker, 1997). Inconsistent with previous research however, the present study found no gender differences between degrees of alexithymia. This sample may not adequately address gender differences as a result of the large differences in number of male and female participants. Therefore, this conclusion should be interpreted cautiously. Scores on the BDI-II were significantly correlated with TAS-20 total scores, consistent with previous research finding strong associations between depression and alexithymia. Consistent with the results of Balmonti et al. (2010), only the DDF and DIF scores were significantly correlated with the BDI-II, providing more evidence that these are the most important factors of the construct. In the absence of any relationships between performance on Animals and physiological reactivity, the presence

of a negative correlation between heart rate and EWFT performance, and of a positive

correlation between skin conductance response and EWFT performance, suggests that the EWFT

does measure affective aspects of verbal fluency. Although FAS performance was also correlated

with heart rate, this may represent an artifact of task order since FAS was the first verbal fluency

task administered. It must also be considered in future research that differences in physiological

reactivity may be due to other factors, such as task difficulty, differential reliance on executive

functioning processes, or activation of different brain areas.

Verbal Fluency

Previous studies on alexithymia have examined a number of cognitive abilities, including

memory, verbal and nonverbal abilities, attention, and executive functioning. Despite a large area

of research in this area, no clear neuropsychological profile of alexithymia has emerged. Deficits

in areas as diverse as executive functioning, sequencing abilities, verbal and nonverbal abilities,

and attention have been supported by some studies and rejected by others. Perhaps as a result of

the characteristic difficulty in *describing* feelings seen in alexithymia, many have focused

specifically on examining verbal difficulties in alexithymic individuals. Using a variety of tasks,

researchers have found deficits in vocabulary, verbal abstract reasoning, and verbal fluency

(Wood & Williams, 2007; Henry et al., 2006). Another commonly cited area of difficulty for

alexithymics is executive functioning (Koven & Thomas, 2010; Bogdanova et al., 2010). The

present study employed the use of a verbal fluency task, as it examines both verbal and executive

functioning abilities. However, there was no association between performance on any of the

verbal fluency measures and degree of alexithymia. In addition, there was no difference found

between the extreme alexithymic groups (low vs. high) on either the phonemic or semantic

fluency tasks. Further, exploratory analyses revealed no associations between these fluency

measures and any of the TAS-20 factor scores. Consistent with the present study, Henry et al. (2006) also failed to find any correlations between TAS-20 Total scores and measures of phonemic, semantic, and alternating (i.e. switching between phonemic and semantic) fluency. However, their study did find negative correlations between the DIF factor and both semantic and alternating fluency, which were not found in the analyses of the present study. The types of populations used in these studies cannot account for these differences as the correlations found in the Henry et al. (2006) study were found in both patient and control groups. One possible explanation for differences in findings on semantic fluency may be Henry et al.'s (2006) use of three different semantic fluency categories (i.e., animals, fruits, vegetables), while the present study used only the "animals" category. Using three categories allows for more variation in scores and makes it easier to find a relationship. Furthermore, the use of a patient population also increases variability in TAS-20 scores, making it even more likely to find a correlation if one exists.

Henry, Bailey, von Hippel, Rendell, & Lane (2010) showed that the lack of a relationship between alexithymia and verbal fluency may not be due to issues with the measurement of alexithymia. They used both a self-report measure (BVAQ) and a performance-based measure (LEAS) of alexithymia to examine verbal fluency. The LEAS is an emotional theory of mind test that allows researchers to measure alexithymia by examining performance on a task rather than relying on self-report. Employing three trials for each type of fluency (phonemic, semantic, and alternating) they found that neither measure of alexithymia correlated with verbal fluency performance. However, Abeare et al. (2009) found a relationship between LEAS performance and phonemic fluency performance, as well as a relationship between LEAS performance and

EWFT performance. Further, EWFT performance predicted LEAS performance above and beyond the variance accounted for by phonemic fluency performance.

An absence of verbal deficits is consistent with a model of right hemisphere dysfunction in alexithymia, although it does not necessarily support it. Onor, Trevisiol, Spano, Aguglia, and Paradiso (2010) assessed a wide range of neurocognitive abilities and found that TAS-20 scores were uniquely predicted by only performance on Raven Matrices and Rey Figure Recall, measures of visual memory and nonverbal general intelligence. Further support for a right hemisphere model of alexithymia comes from a study (Bogdanova et al., 2010) that found a correlation between alexithymia and visuospatial functions. Nonverbal/visual abilities are largely subsumed by the right hemisphere. However, the results of the present study alone cannot rule out an absence of verbal deficits.

Verbal abilities encompass a vast number of separate abilities and verbal fluency is just one aspect of verbal functioning. In addition, since verbal fluency tasks also rely heavily on frontal processes, the absence of a correlation between alexithymia and verbal fluency may instead suggest that alexithymia is not associated with executive functioning deficits. Thus, the model of frontal lobe dysfunction in alexithymia was not supported by the present study. These findings are consistent with results of a study (Wood & Williams, 2007) that found a negative correlation between alexithymia and measures of vocabulary, abstract verbal reasoning, and general fund of knowledge, but not with measures of executive functioning. As other studies have found evidence supporting executive functioning difficulties (Koven & Thomas, 2010; Huang et al., 2005), future research needs to examine the various executive functioning processes systematically.

Emotion-Processing

Despite the prediction that alexithymia would have a negative association with the emotion word fluency task, this finding was not demonstrated in the present study. As with the other verbal fluency measures,no difference was found between the lowest and highest scoring individuals on the TAS-20 on this task. In addition, scores on the DIF, DDF, and EOT factors were not predicted by performance on the EWFT. However, this does not necessarily suggest that alexithymic individuals have intact emotion-processing or emotion communication. Instead, these results may clarify the nature of the difficulties these individuals have with emotion processing and production and thereby guide future research in this area.

A number of previous studies have suggested that individuals with alexithymia may have both verbal and nonverbal emotion-processing difficulties. Although the present study cannot make any conclusions about nonverbal affective abilities, it does suggest that individuals higher in alexithymic traits do not have difficulties with emotion word production when that process is isolated. In this task, speed and number of words produced are emphasized, whereas other researchers have employed tasks that rely on judging the valence of emotion words (Gong & Gong, 2008) or on producing affective words in reaction to emotional stimuli (Roedema & Simons, 1999). Therefore, the results of the present study cannot be generalized to situations in which individuals higher in alexithymic traits are required to make judgments about affective words or produce emotion words to describe their own or others feelings. Depth of processing models must also be considered in this context. Judging the valence of emotion words requires a deeper level of processing than does quickly coming up with emotion words. However, previous studies employing level of processing paradigms (Luminet et al., 2006) have suggested that alexithymics are impaired at remembering affective words processed at both shallow and deep levels.

Although some studies have suggested that alexithymics have a smaller vocabulary (Wood & Williams, 2007), the results of the present study may seem to suggest that emotion word vocabulary is not associated with degree of alexithymic traits. However, being able to produce emotion words does not generalize to an ability to understand the meaning of those words or an ability to link the meanings with physiological sensations of emotion. For example, Roedema and Simons (1999) suggested a limited affective vocabulary in alexithymia as participants with higher TAS-20 scores generated fewer emotion-related words to describe their own reactions. Thus, emotion word production may only be impaired in alexithymic individuals when they are attempting to describe their own or others' feelings. Some researchers have suggested that alexithymia consists of an inability to link verbal and non-verbal aspects of emotion. Thus, although high alexithymic individuals may have a comparable affective vocabulary, their ability to associate those words with nonverbal aspects of emotion (facial expressions, bodily sensations, etc.) may be impaired. If the core deficit in alexithymia is an inability to create symbolic representations of language, the results of this study suggest that it does not stem from problems in verbal deficits, although future research will need to examine verbal abilities other than verbal fluency to assess this hypothesis. Despite the absence of a correlation between performance on the EWFT and alexithymia, it cannot be concluded that there are no verbal emotion-processing deficits associated with high degrees of this trait. Future research may wish to explore the possibility that, although those higher in alexithymic traits may have an intact vocabulary of affective words, they are unable to successfully identify the physiological sensations associated with the words or are unable to recognize the associated facial expressions and body language in others.

Although the present study made no hypotheses about the valence or arousal level of the emotion words produced, future research may wish to examine these variables, as some studies have suggested that the emotion-processing difficulties in alexithymia are specific to negative emotions. For example, the difficulty describing feelings factor was associated in one study with a poorer ability to detect expressions of negative emotions in a speeded condition (Parker et al., 2005).

Physiological Arousal

It was hypothesized that alexithymia would be associated with differences in autonomic nervous system functioning, as measured through blood pressure, heart rate, and skin conductance. No specific hypotheses were made as to whether alexithymia would be associated with higher or lower levels of autonomic arousal, but it was predicted that these differences would be seen at all three time points during the study: baseline, during performance tasks, and at recovery. In the original analyses conducted, there were no associations between alexithymia and any of the physiological measures at any of the three time intervals.

With regards to conflicting findings about the association between degree of alexithymic traits and tonic autonomic arousal, a number of explanations have been proposed. Some have suggested that short baseline periods explain the lack of differences in baseline physiological measures found in some studies. For example, Luminet et al. (2004) used only a 30-second baseline and found no association between alexithymia factor scores and tonic heart rate or blood pressure. However, other studies employing baseline periods as long as 15-minutes have also failed to produce any differences in tonic autonomic arousal between alexithymics and controls (Neumann et al., 2004).

An alternative explanation for differences in tonic levels of autonomic activity is sample characteristics, such as gender or culture. Consistent with the results of the present study, a number of other studies with a majority of female participants have failed to find any differences in skin conductance (Roedema & Simons, 1999), heart rate or blood pressure (Neumann et al., 2004) at baseline, while a study of all men did find differences in tonic autonomic arousal (Fukunishi, 1991). Inconsistent with this hypothesis, however, are studies finding no differences in samples of both men and women (Luminet et al., 2004) and studies finding differences in skin conductance in a population of female participants (Friedlander et al., 1997). Future research should include equal numbers of males and females and to examine gender as a possible confounding variable. In terms of culture, Neumann et al. (2004) suggested differences in baseline physiological arousal between their typical North American sample (Caucasian majority) and Fukunishi's (1991) population of Japanese men were potentially influenced by cultural differences. Although the Caucasian majority found in the present study is consistent with Neumann et al.'s (2004) sample, a wide range of other ethnicities were identified as well. Future studies may wish to examine cultural differences in a systematic manner; for example, culture could be used as a potential covariate in studies of alexithymia and autonomic dysregulation.

When examining autonomic reactivity to the verbal fluency tasks, the present study provides no evidence for higher or lower levels of arousal being associated with scores on the TAS-20. The results of this study cannot rule out autonomic dysregulation in alexithymics in response to emotion-provoking stimuli, as the verbal fluency tasks constitute cognitively-demanding tasks. The pattern of changes in NSSCRs and heart rate from the semantic fluency (Animals) task to the EWFT suggests that quickly coming up with emotion words measures a

unique aspect of verbal fluency that is affectively activating in nature. This is supported by the presence of a relationship between physiological reactivity and the EWFT, but not Animals, as both are semantic fluency tasks. The production of emotion words seems to evoke different physiological reactions in comparison to the production of the names of animals. However, the absence of a relationship between TAS-20 scores and measures of autonomic nervous system activity during verbal fluency tasks suggests that alexithymia is not associated with physiological differences during the executive, verbal, and affective aspects of verbal fluency tasks. In contrast to the results of the present study, a study employing both a "mental load" condition and an "emotional load" condition found that alexithymics exhibited fewer nonspecific skin conductance responses during both (Franz et al., 2003).

The present study found no association between alexithymia and autonomic arousal during a recovery phase. Neumann et al. (2004) found evidence for longer recovery periods in alexithymic individuals following an anger recall task, while the current study examined recovery following a cognitively demanding task. These differences may suggest that alexithymia is associated with a longer recovery period of the autonomic nervous system following an emotionally-stressful task, but not following a cognitively-stressful task. However, these results will need to be replicated with larger sample sizes before such conclusions are warranted.

Exploratory analyses in this study found that physiological arousal changed over time during the performance measures. However, there was no interaction with alexithymia scores, suggesting that these changes in arousal were independent of alexithymic traits. Although alexithymics may not exhibit dysregulation of the autonomic nervous system at baseline or during cognitively demanding tasks, other research supports dysfunction in response to

emotionally provoking material or situations. Although there was a pattern of increased NSSCRs and decreased heart rate from the semantic fluency (Animals) task to the EWFT, and correlations between performance on the EWFT and physiological reactivity, the EWFT task may not measure the areas of emotion-processing with which alexithymics struggle. While individuals higher in alexithymic traits may not demonstrate difficulties in the affective aspects of verbal fluency, according to previous research they do seem to demonstrate other difficulties in affective word production: producing words to describe own emotional reactions (Roedema & Simmons, 1999) and judging the valence of affective words (Gong & Gong, 2008).

Methodological Considerations

Future research examining alexithymia and verbal fluency may wish to take some methodological considerations into account. First, the present study used only one trial of semantic fluency, while other study designs (Henry et al., 2006; Henry et al., 2010) have used three trials of different semantic categories, which may provide better information about performance on this type of task. The use of three categories also allows for greater variation in scores, thereby making it easier to identify an existing correlation. These researchers have also included tasks of alternating fluency, which were not used in the present study but have been shown to be associated with difficulty identifying emotions in at least one study (Henry et al., 2006). In regards to the EWFT, future research may wish to examine the types of emotion words produced (e.g. positive and negative emotion words). In order to force either negative or positive emotion word production, the EWFT could also be broken down into two separate tasks (i.e. negative emotion word fluency, positive emotion word fluency). Lastly, the order of verbal fluency tasks should be randomized to control for any temporal effects of task order.

In the present study, alexithymia was conceptualized as a dimensional variable, as suggested by Parker and Bagby (1993). However, in order to examine the possibility of subgroups in alexithymia, future research may wish to use the clinical cut-offs of the TAS-20 to create non-alexithymic and alexithymic groups. This type of research could use clinical populations, where the rates of alexithymia are higher. As the literature suggests two different types of alexithymia, acquired and developmental (Taylor, Bagby, & Parker, 1997), future research may also wish to examine possible differences between these two subtypes.

In the present study, blood pressure was taken immediately following each of the verbal fluency tasks. The reasoning behind this decision was to make performance on the verbal fluency and EWFT tasks comparable to that of the initial set of participants who did not have blood pressure measured at any point during the study. In future research, however, blood pressure could be measured during the tasks to get a more accurate idea of autonomic reactivity during performance measures. In terms of factors affecting measures of physiological arousal, future research should control for the duration of physical activity and amount of caffeine intake prior to study participation. The present study was conducted over a time period of ten months and although it was not assessed in these analyses, future research may wish to consider the impact of season effects, as arterial blood pressure has been shown to be higher in winter than summer months (Brennan, Greenberg, Miall, & Thompson, 1982).

Although the present study did not find associations between alexithymia and measures of heart rate variability either at baseline or during a recovery period, these measures do not assess the *reactivity* of the sympathetic and parasympathetic branches of the autonomic nervous system. Future research should compare the differences in heart rate variability pre- and post-performance tasks to examine estimates of reactivity.

Conclusions

In this experiment, cognitive and emotion-processing abilities as well as physiological functioning where examined in association with degree of alexithymia in a sample of university students. The present study assessed affective, physiological, and cognitive aspects of alexithymia. Prior to this study, no known research has taken all of these variables into account in one study of alexithymia. Although we found no relationship between physiological, cognitive, and emotional variables, it cannot be concluded that such relationships do not exist, based solely on the findings of this study. The goals of future research will be to help resolve the noted inconsistencies in the literature and to further understand the physiological, cognitive, and affective aspects of alexithymia.

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