The Language Dimension of Psychopathy: From Signal Analysis to Social Perception

by

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Abstract

Psychopaths have long been associated with a unique ability to manipulate others (Hare, 1999). To shed more light on language production in psychopathy two studies of language production were performed comparing content and fluency under different motivational and difficulty conditions. It was observed that individuals high in psychopathy (HP) were less fluent but maintained a more complex lexicon, than their low psychopathy counterparts, when under high cognitive load and low motivation. Yet when the HP individuals were under low cognitive load and high motivation, they were more fluent, but produced less complex lexicon. Furthermore, it was found that the HP group produced more emotional language in both conditions. The results suggest that HP individuals' linguistic abilities are inherently related to motivation. Results are discussed in terms of Theory of Mind and emotion perception processes.

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1 Chapter: **Theoretical Foundations**

Psychopaths have long been associated with a unique ability to manipulate others (Hare, 1999). However, despite this claim, almost all forensic psycholinguistic research investigating psychopathy has focused on language perception, not production. To shed more light on language production in psychopathy, the goal of the present project was to explicate a theoretical background for the interaction of language production models and psychopathy models. First, I review theories of psychopathy, then theories of language production. Following this, I attempt to integrate theories of psychopathy and theories of language production via the mediating factor of cognitive load. Finally, speech disfluencies are explored as a potential manifestation of cognitive load during speech production.

To further this goal, I carried out two studies to investigate the relationship between psychopathy and language abilities. The first study, discussed in Chapter 2, is a ‘proof of concept’ for an analysis of silent disfluencies in speech. Aside from speech analysis, this study also sampled emotional content of speech. In Study 1, participants from an undergraduate population were asked to produce a fictitious monologue with no audience. Participants were asked, when prompted by an emotionally charged scene, to create and verbalize a story as if they were a character in the story. Participants were measured on several personality traits including psychopathy and behavioural inhibition. Although this exploratory study suffers from several methodological drawbacks, results indicated that individuals who have high psychopathy scores really do suffer a reduction in fluency when producing semi-spontaneous fictitious stories. A follow-up to study 1, also described in Chapter 2, subjected the fictional stories to peer evaluation on

qualitative factors such as flow, emotional appropriateness, truthfulness, appeal, etc. A second study in this series, discussed in Chapter 3, attempted to validate the content analysis of the previous study using interviews with incarcerated youth. This study uses significantly different content for analysis due to the presence of an interviewer, question-answer type of conversation, and the presumably truthful nature of participant responses.

Contrary to popular belief, psychopathy, like all other personality traits, exists on a spectrum of severity (Gunter, Vaughn, & Philibert, 2010). A natural consequence of this is that all individuals possess psychopathy traits to some degree. Although it is possible to categorize the general population into those low and high in psychopathic traits, this is not a binary distinction of “psychopath” and “normal”. It is even possible to suggest that individuals “too low” in psychopathy traits may be overly pro-social and emotionally empathetic such that they may easily fall victim to the manipulation of others.

The most recent iteration of the American Psychiatric Association’s (APA) Diagnostic and Statistic Manual of Mental Disorders 5th edition (DSM-V) does not recognize psychopathy as a mental illness or disorder (American Psychiatric Association, 2013). For its part the DSM-V does not, on principle, pathologize criminal activity or activity seen as socially deviant, a historical lesson learned from previous pathologization of homosexuality (Byne, 2014). Currently, the theoretical framework for DSM-V disorder inclusion relies on criteria of personal distress and functioning in society. Any phenomenon, or manifestation of behaviour, ought not be diagnosed as a mental disorder if it neither distresses the individual nor disrupts their ability to function in society. This places psychopathy in an interesting position, since part of the criteria for identification

of psychopathy by widely used measures of psychopathy includes the presence of aggression, manipulation, and a parasitic lifestyle. One could argue that these traits are the very definition of an inability to function in society. However, the prevailing opinion holds that self-centered and manipulative behaviour ought to be conceptually separate from dysfunction.

Simply because psychopathy does not meet the criteria for inclusion into the DSM-V, does not imply that psychopathy has poor conceptual coherence. An impressive body of literature has accumulated on the topic of psychopathy, continuously reaffirming the validity of the construct.

1.1 Psychopathy

Modern psychopathy research begun with the advent of the Psychopathy Checklist-Revised (PCL-R) by Robert Hare (Hare, 2003). The PCL-R is currently the most widely used tool in both psychopathy research and forensic settings (Miller, Gaughan, & Pryor, 2008). The PCL-R measures two factors of psychopathic personality: Factor 1 assesses emotional and interpersonal characteristics whereas Factor 2 assesses impulsiveness, and antisocial behavior. Individuals who rank high on Factor 1 and who lack anxiety are categorized as “primary psychopaths” (Hicks et al., 2011). Primary psychopaths are manipulative, egocentric, callous, glib, and have a pronounced lack of anxiety (Ashton, Lee, & Son, 2000). Factor 2 of the PCL-R assesses past behaviors of social deviance, such as impulsivity, aggression, and parasitic lifestyle (Hicks, Markon, Patrick, Krueger, & Newman, 2004). Individuals who score high on Factor 2 are characterized as “secondary psychopaths” (Hicks et al., 2011). Secondary psychopaths tend towards hostility and impulsivity (Hicks et al., 2011; Hicks et al., 2004) resulting in

a personality of persistent aggression and antisocial behavior (Porter & Woodworth, 2006).

Psychopaths have an effect on society out of proportion to their actual numbers; although they comprise an estimated 1% of the total population (Coid, Yang, Ullrich, Roberts, & Hare, 2009), they represent up to 15% to 22% of prison populations (Castellano, 2013). Theories attempting to explain the phenomenon of psychopathy can broadly be separated into three categories: emotion-based models, cognition-based models, and unified theories. Although not mutually exclusive, as will be made obvious in the section on unified theories of psychopathy, there is a historic divide between emotion-oriented models and cognition-oriented models. Emotion-based models focus primarily on aberrant emotional responses and emotion perception within the psychopathic population. Cognitive models attempt to place the root cause of the psychopathic personality on general perception and attention malfunctions. Finally, the recently developed unified theories of psychopathy attempt to explain the causal mechanisms that precede both the cognitive and the emotional phenomena.

1.1.1 Emotion Based Models

One of the earliest models that attempted to explain the phenomena of psychopathy is Lykken's (1957) research on the abnormal fear response in psychopaths. Lykken conducted a classical conditioning experiment using electric shock as the conditioning stimulus. He found that psychopaths had significantly lower galvanic skin response to conditioned shock stimuli, and showed very little punishment avoidance behavior, implying that psychopaths experience a much lower level of stress/ anxiety in the anticipation of unpleasant stimuli. Lykken proposed a behavioral theory of

psychopathy that relates psychopathy to inappropriate associations between behavior and negative stimuli. Lykken hypothesized that psychopathic individuals have “defective avoidance learning” (p. 9) and this results in an impaired ability to condition an avoidance response. As with most purely behavioural research, Lykken, despite offering a detailed description of the phenomenon, was unable to suggest an explanatory model.

Expanding on Lykken’s (1957) low-fear theory of psychopathy, Blair (2005, 2006) included a neurocognitive component to create the integrated emotion systems (IES) model of psychopathy. At the heart of Blair’s theory is the idea that individuals with psychopathic tendencies have a malfunctioning amygdala. The amygdala has been shown to play a crucial role in recognition of fearful facial expressions and emotional learning (Marsh & Blair, 2008). Impaired amygdala functioning is hypothesized to create the underlying conditions for poor socialization and reduced empathy among the psychopathic population. As an example, this theory might explain continued criminal behaviour in the face of punishment by suggesting that a psychopathic individual would be unable to perceive the negative effects that their actions have on others because they are hindered by their limited emotion recognition abilities. Furthermore, the psychopathic individual, if punished, would not associate their own emotional response elicited by the punishment to their previous actions. From the standpoint of the present project, this model is particularly unsatisfactory, because it does not account for the aberrant language abilities of the psychopathic population.

1.1.2 Cognitive Models

Newman and colleagues (Newman & Baskin-Sommers, 2012; Newman, Gorenstein, & Kelsey, 1983; Newman, Schmitt, & Voss, 1997) developed a competing

model of psychopathy called the response modulation (RM) model. Newman and colleagues proposed that psychopaths are unable to focus their attention on stimuli that is secondary to their goal-oriented behavior. This was later developed into a proposal that psychopaths have difficulty accommodating bottom-up, stimulus-driven information, when it is inconsistent with the top-down, effortful focus of attention (Blair & Mitchell, 2009). This inattention causes a deficiency in processing information, such as social norms, laws, and ethics, which contradict goal- and reward-oriented behavior of the individual. However, when goal-oriented behaviour is concurrent with the behaviour under investigation, there is no detectable deficiency in cognitive processing abilities. This is hypothesized to be a factor of early attention over-focusing on the reward and a bottleneck in the perception and processing of alternate stimuli (Newman & Baskin-Sommers, 2012). Although the specific nature of the cognitive dysfunction is still under investigation, evidence so far suggests the attenuation of complex and integrative cognitive processes while concrete cognitive processes remain unaffected (Kiehl et al., 2004). The apparent result of the RM model is a disinhibited personality that cannot delay gratification, and suffers over-conditioning behavior from rewarding stimuli that is very resistant to change. As an example, this theory might explain continued criminal behaviour in the face of punishment by suggesting that a psychopathic individual when faced with a potential reward would be blinded to the potential consequences or risks, simply because their attention is too narrow to incorporate nongoal-directed cognition.

1.1.3 Unified Theories

Unfortunately, neither the low-fear nor the response modulation models of psychopathy provide a satisfactory explanation for all aspects of psychopathic behaviour.

However, because there is no concrete evidence to suggest that emotion and cognition form two distinct and separable functions (Pessoa, 2008) or neural structures (Pessoa, 2012), it is plausible to view the two systems as inherently intertwined. Building on this, researchers have been pushing for the unification of emotional and cognitive models by attempting to find underlying neurocognitive causes.

The first attempt to integrate emotional and cognitive accounts of psychopathy was the differential amygdala activation model (DAAM) (Moul, Killcross, & Dadds, 2012). Moul and colleagues suggest that the basolateral amygdala is underactive, while the central amygdala is over active. The authors suggest that the basolateral amygdala is responsible for stimulus-outcome associations, and altering the allocation of attention based on environmental stimuli. They argue that the central amygdala is responsible for the encoding of motivational valence of stimuli, “to drive reflexive behavioral responses to fear eliciting conditioned stimuli” (p. 13), and to shift focus when the value of a reward diminishes. Moul et al. suggest that poor fear recognition is due to an impairment in the reflexive shift that is responsible for shifting gaze to the widening of eyes, where the fear emotion is conveyed. The deficits in punishment avoidance are hypothesized to be due to over-conditioning of the central amygdala, which is responsible for general valence learning and suppresses specific-feature learning that the basolateral amygdala is responsible for.

Building on Moul et al.’s (2012) initial attempt at unification, Hamilton, Racer, and Newman (2015) introduced the impaired integration (II) theory. Hamilton and colleagues propose that the best way to integrate the cognitive and emotional models of psychopathy is with the use of neural network theory. Network theory posits that

cognition is more a factor of integration and communication between areas of the brain than it is within these areas of the brain. In the II theory, psychopathy is a manifestation of poor network integration. Hamilton and colleagues suggest that the interpersonal and affective symptoms of psychopathy are due to poor integration of the default mode network (DMN) and the salience network (SN). The DMN is responsible for baseline (default) behavior of introspection, rumination, and future perspective taking. The DMN is believed to be autonomous, stimulus independent and typically suppressed by executive function or goal oriented behavior. The SN directs and facilitates access to attentional resources and working memory. The SN is activated by salient biological, emotional, or cognitive information. The function of the SN is a crucial component of flexible and adaptive behavior. Hamilton et al. argue that poor integration between DMN and SN causes the observed behavior of habitual response style and poor integration of external information. They also point out that when effort is applied, top-down control is activated as one would expect to observe in the normal population. It should be noted that in previous research it has been suggested that the top-down effort must be in form of reward oriented goal-directed behaviour (Newman & Baskin-Sommers, 2012).

One pertinent aspect of the II theory is the explicit integration of language processing into its predictions. Although, no specific claims are made regarding language cognition in psychopaths, Hamilton et al. (2015) suggest that a lack of synchronization between sensory/perception and the temporal parietal cortex impairs, and increases the cognitive load required for abstract word processing (Hamilton et al. 2015, p. 728).

1.2 Language Production

1.2.1 Classical Model of Language Production

Levelt's (2001) theory of lexical access and utterance production is the modal theory of language production. Levelt's theory is a classical cognitive explanation of the interaction between lexical focus, and the initiating utterance production, within the framework of motivation and pragmatics. Levelt proposes a serial two-system architecture consisting of lexical selection and form encoding that co-occur and compete for mental resources.

First lexical selection occurs; it begins with conceptual focus and perspective taking and concludes with lemma selection. Perspective taking is the preparation of conceptual content for the purpose of meaningful communication. Perspective taking is a constant phenomenon that appraises the individual's relation to the context present in their environment. For example, if asked a question, perspective taking would be the process that determines, among other things, if one should be honest or polite. The second part, lexical selection, involves the selection of lemmas for speech production. Lexical concepts are broad, conceptual, proto-words that have a loose relation to lemmas. Lemmas are abstract conceptual forms of specific words (Fodor, 2008). For example, the lexical concept for "running" would contain lemmas such as: jogging, sprinting, dashing, etc. After lemma selection, a crossover to the form encoding system occurs. At this crucial junction between lexical selection and form encoding "tip of the tongue" (TOT), a phenomenon in which a speaker remembers the concept and can even describe aspects of its form but cannot find the appropriate word, may occur (Levelt, 2001, p. 13465). Recent studies using magnetoencephalography on individuals with experimentally induced TOT

states confirm the existence of two distinct structures for perspective taking and form encoding (Resnik, Bradbury, Barnes, & Leff, 2014). The processes involved in lemma selection broadly fall under the criterion of macroplanning language production, whereas the subsequent system of lemma encoding falls under the criterion of microplanning.

Once a lemma is selected, individuals encode word forms prior to articulation. The first step of form encoding is retrieval of phonological word codes. A morphemic phonological code, the verbal form of a word, is believed to only be activated once lemma selection occurs. For words that are multimorphemic, a phonological code is retrieved for both sets of morphemes required. At this stage, errors can occur in phoneme selection, such that there are two phonemes selected and both are verbalized simultaneously. Such errors can lead to unintentionally humorous responses, for example, when one attempts to answer “fine” and “good” simultaneously, the verbalization is “food”.

Following the phonological coding of a target word, syllabification and prosodification occurs. The phonological codes provide a blueprint for base units of pronunciation, the syllables. Levelt argues that syllabification and prosodification co-occur and the result is a phonological word. Finally, phonetic encoding occurs to create an articulation score for each phonological code. At this point, the articulation score is ready for verbalization.

1.2.2 Alternative Models of Language Production

Developing an utterance macro-plan is more cognitively demanding than the articulation itself (Kemper, Hoffman, Schmalzried, Herman, & Kieweg, 2011). Based on this notion, MacDonald (1999) proposed the Production-Distribution-Comprehension

(PDC) account of language. The planning process proposed by MacDonald is not language specific, but applies to all forms of planning. The PDC model suggests that one of the most important aspects of speech production is the minimization of cognitive load, while maintaining verbal fluency. Planning of utterances precedes the production, creating a trade-off between advanced planning and speed of execution. If one starts to speak too early and is not able to preplan enough, or store a sufficiently long macroplan in working memory, a mid-phrase disfluency may occur, that acts functionally as a buffer for cognitive planning. Furthermore, self-monitoring activity must also take place to track progress through the utterance plan, avoid repetitions, and omissions. Self-monitoring creates extra cognitive load. The constant pressure from cognitive constraints to simplify language utterance plans has two consequences (MacDonald, 2013). First, this creates language regularities through the consistent use of cognitive strategies (described in further detail in section 1.4.1) for increasing fluency and decreasing cognitive load. The consistent use of language production strategies over time leads to patterned language performance. This in turn leads to the second consequence: regularities determine many aspects of language comprehension. MacDonald argues that along with formal grammars, new language learners learn the performance of utterances (or statistical pattern of language) and employ that as part of their own language production and comprehension systems. This results in not only a change in production from one generation to the next, but also a change in perception and comprehension. This cycle produces generational changes that MacDonald argues are cross-cultural and are based in fundamental cognitive architecture.

An alternative model of language production is the retrieval-based model of language processing (Johns & Jones, 2015). Johns and Jones suggest that during language acquisition, exemplars of language are stored in perceptually-grounded semantic memory. The exemplars are later used to generate expectations of future language use, thereby creating a structured language system. Johns and Jones suggest that language is a remarkably bottom-up phenomenon that is highly dependent on context and previous language use. This model is built on previous work on perceptual symbol systems (Barsalou, 1999, 2003). In Johns and Jones' model, most aspects of language are innately tied into human perception. Consequently, any individual difference in perception would be reflected in the language of that person. Furthermore, Johns and Jones do not explicitly state that their model of language production uses working memory, or that language production creates cognitive load, but they do suggest that an exemplar memory is used to generate predictions about future language structure. Nonetheless, the exemplar memory system would be subject to the same principle of finite cognitive resources analogous to other models that explicitly posit working memory or cognitive load.

Although theoretical explanations of language production are relatively new, the practical implications of the communication channel limitations have been observed, and subsequently modeled, for over 80 years. According to Zipf (1935), the relationship between the rank and frequency of a word in a language corpus when plotted on a logarithmic scale will have a linear relationship, with the ideal line of best fit having a slope of -1, a relationship now known as "Zipf's Law". Zipf suggested that with this relationship human communication is optimal and a balance between transfer of information and effort exerted is reached. A change in the slope indicates a change in the

expected balance between frequent and infrequent words. Infrequent words are typically more complex because they are longer and are more specific in their use (such as articles).

This phenomenon was explained by Zipf in terms of the principle of least effort (Zipf, 1950). Similar to the PDC model, the principle of least effort posits that all people strive to communicate the maximum volume of information with the minimum effort. Although, unlike MacDonald (1999), Zipf's primary focus was on the usage of individual words outside of context and cognitive factors (e.g., frequency of use). This underdevelopment leaves the Zipf's law limited in its utility for determining underlying cognitive structures. However, Zipf's law can be utilized to determine if there is a distinction between subsets of a corpus or randomly selected individuals. Using this model, it is possible to compare deviations between natural language and the "ideal" case, and contrast the deviations of subsets of the corpus to arrive at an indication of how optimal it is. Zipf's law has been shown to hold true in many instances of natural language (Edwards & Collins, 2011) and has had a large impact on a wide range of scientific fields (Chang, 2016).

All the aforementioned theories of psychopathy and language production have a common element of working within the framework of constrained resources. Although this is not a novel concept for cognitive research, it is of particular importance in the field of forensic psycholinguistics because language production in its own right consumes a massive amount of cognitive resources (Kemper et al., 2011). As such, even under normal spontaneous speech production conditions any given individual could very quickly surpass their verbalization macroplan and begin to experience difficulty

maintaining verbal fluency. Given the cognitive deficits that the psychopathic population is believed to experience, these individuals should require greater resources for maintaining verbal fluency. In the following section I will discuss cognitive load and its relationship with verbal fluency.

1.3 Cognitive Load and Forensic Psycholinguistics

1.3.1 Theory of Cognitive Load

The concept of cognitive load is generally credited to John Sweller (Brünken, Moreno, & Plass, 2010; Sweller, Kalyuga, & Ayres, 2011). In the 1980s Sweller suggested that individuals who are attempting to learn a new task are limited by the relationship between the complexity of the task, and their working memory capacity (Khawaja, Chen, & Marcus, 2014). Cognitive load theory makes explicit a distinction between “primary” and “secondary” knowledge. Primary knowledge is believed to be aspects of our lives for which we are evolutionarily adapted, such as speaking our native language, recognizing faces, and performing basic problem solving tasks. Secondary knowledge is argued to be evolutionarily more recent and is grounded in cultural knowledge such as reading, writing, and most educational subjects.

The difference between primary and secondary knowledge is argued to arise from the nature of cognitive architecture. Sweller et al. (2011) argue that in contrast to primary knowledge, the acquisition of secondary knowledge requires a general cognitive architecture applicable to a wide variety of areas, rather than modular systems specific to a particular area. This type of cognitive structure relates to a class of cognitive models referred to as dual-process theories. The term “dual-process theory” is a blanket descriptor for a category of theories that have been argued to provide better explanation

for observed data than either classical or connectionist models alone (Evans & Frankish, 2009).

Most famous dual-process model is depicted in “Thinking Slow and Thinking Fast” (Kahneman, 2011) as system one and system two. Dual-process theories give a reasonable alternative to the chief executive/ classical models of cognition (Evans, 2010) and allow for the synthesis of connectionist and classical cognitive models. Classical cognitive scientists subscribe to formal methods which focus on understanding and explaining the rules, or laws, by which cognition functions whereas connectionists are focused on biologically grounded methods and attempt to extend the dominance of biology over cognition. Because of their differing methods, theories, and philosophies, an explanatory rift exists between classicist and connectionist models of cognition to which dual-process theories offer an attractive solution. The dual-process models argue that there are two distinct systems underlying human reasoning with the first fitting the mould of connectionist models, and the second fitting the mold of the classicist models (Evans & Frankish, 2009; Evans & Stanovich, 2013; Sherman, Gawronski, & Trope, 2014). The first system is an evolutionarily old system that is associative, automatic, unconscious, parallel, fast, specialized, and difficult to modify. The second cognitive system is an evolutionarily recent system that is rule-based, controlled, conscious, serial, slow and highly adaptive. The old system is innate and uses heuristics that evolved to solve specific adaptive problems such as perceiving emotions or using our motor skills, while the new systems are flexible, responsive to rational norms, and are largely learned. The two cognitive systems are seen as dissociable, and thus distinct, since each can be impaired without affecting the other system’s functions. However, this does not imply

that these cognitive systems are completely distinct. For example, face and visual object recognition share some sub-systems (Lyons, 2003). As such, cognitive load theory places primary knowledge acquisition into the domain of the evolutionarily older model, while the secondary knowledge is in the domain of the evolutionarily newer model.

As an individual attempts to learn secondary knowledge, the information that they are attempting to process enters their working memory. Within working memory this information must be organized, and conceptualized/ schematized before it can be properly stored in long term memory (Sweller et al., 2011). Sweller suggests that cognitive load is determined by three factors: intrinsic cognitive load, extraneous cognitive load, and germane resources.

Intrinsic cognitive load is imposed by the nature of the material and is not alterable. This load is viewed as the inherent complexity of the material, and the mental resources required to interpret the information. Extraneous cognitive load is the method by which the information is delivered and can be more or less suitable for the material and the individual. This load is often the target of manipulation through changing of teaching techniques. The final factor affecting cognitive load is germane resources (previously, germane cognitive load) that encompasses our capacity to conceptualize and schematize the incoming information. Sweller et al. (2011) argue that the various factors that affect cognitive load are additive, and if their cumulative effect surpasses the available working memory resources required to deal with the load, the cognitive system will fail, at least in part, to process necessary information.

Much of the research performed in the area of cognitive load focuses on the acquisition of knowledge and the methodology by which one can simplify the

information to reduce the extraneous cognitive load (Kirschner, Ayres, & Chandler, 2011). While this area of research has been predominantly focused on complex information apperception, researchers in fields outside learning have taken it as trivially true that this construct can be applied to all cognitive processes, including language production, thereby confounding cognitive load with mental effort (Kirschner & Kirschner, 2012).

Mental effort is a broad term referring to the predominantly subjective experience of difficulty in information processing and other mental tasks (Kirschner & Kirschner, 2012). The concept of mental effort has evolved from a concept of “mental energy” (Mulder, 1986). Mental energy, prior to the cognitive revolution, attempted to explain why mentally challenging tasks exhausted and induced stress in individuals, in spite of a lack in observable behaviours. A more formal theory of mental effort was developed by Kahneman (1973) in *Attention and Effort*. Kahneman argued that mental effort is a theoretical measure of how much of your available resources you devote to a task. He concludes that the resources expended have a logarithmic structure and can be estimated, although not reliably, through physiological arousal. Kahneman suggests the biggest determinant of mental effort is momentary task difficulty which is determined by time-sensitivity, and time sensitivity is inherently tied to the demands on working memory. Simply put, the concept of mental effort is synonymous with “how hard is your brain organ working” as related to physiological metabolic activity (for example, see Fairclough & Houston [2004]).

An analogy must be made to elucidate the predicament that we find ourselves in. An individual is tasked with carrying apples from point A where they receive them, to

point B where they deposit them. Working memory may be represented by how many apples the individual can hold. In this scenario, cognitive load would be how efficient they are at the task and mental effort would be how much energy the individual expends performing the task. The productivity of the task would be determined by a number of factors, including the rate at which apples are received (fast or slow), how they are delivered (loose and scattered or boxed and stacked), and how many an individual can carry. The energy spent on this task at any given moment would be determined mostly by the time restraints in which we must complete the task. Both the measure of cognitive load and mental effort are without doubt related, and will be affected by any change in the individual or the situation. However, the real problem is that knowing everything there is to know about a person's efficiency at, and energy expenditure on, receiving and storing apples, does not necessarily relate to their ability, and the underlying mechanisms, for them sorting and handing out apples. And even if it the two concepts similar, the concept of mental effort lacks the cognitive explanatory power to elucidate the underlying phenomenon, while the concept of cognitive load explains a very different set of cognitive mechanisms.

Although the concept of cognitive load was never intended to be applied loosely, it remains conceptually lucrative in its ability to provide an insight into cognitive underpinnings of language production. To this end, I will elaborate on the parallels between factors affecting language production and the three factors that affect cognitive load.

1.3.2 Cognitive Load and Speech Production

An interesting parallel can be made between dual process models in general, specifically Sweller's et al. (2011) cognitive load theory, and Levelt's (1989) model of language production. Although Levelt's (1989) model of language production has not been explicitly intertwined with dual-process models, the framework, and some empirical evidence, suggest they are analogous. Recall that Levelt (2001) proposes a serial two-system architecture consisting of lexical selection and form encoding that co-occur and compete for mental resources such as working memory. According to Levelt, perspective taking and lexical selection occur in the first system, followed by lemma selection and encoding in the second system. Furthermore, experimental evidence has shown that speakers first plan the use of words reflecting the hierarchical dependencies of their message, and then syntax linearizes the words into a coherent form (Lee, Brown-Schmidt, & Watson, 2013), giving very high credibility to the existence of dual processes for macroplanning and microplanning of speech. According to Levelt, the competition for the limited cognitive resources between the two systems may surpass the available working memory resources required to deal with the load and the cognitive system will fail, at least in part, to produce fluent speech.

Although there is no direct evidence that the constructs of cognitive load, as described by Sweller et al. (2011), and speech production, as described by Levelt (1989), are related, there is reason for cautious optimism that the construct of cognitive load can be applied not only to the apperception, but also to the conceptualization and production of information. Specifically, if we apply the theory of cognitive load to speech production, it is possible to draw some parallels. Intrinsic cognitive load in speech

production can be said to be imposed by the inherent nature, and subjective difficulty, of the lexical concepts an individual is accessing. Extraneous cognitive load would be affected by the method of information delivery, such as the fluency of the language we are speaking. Finally, the germane resources would encompass our capacity to conceptualize, schematize, and to forecast a macroplan for the information we wish to convey.

Since the language conceptualization and production system does not exist in a vacuum, cognitive resources will be tapped by other competing systems such as self-monitoring. If the cognitive resources available are overwhelmed by the demands, speech becomes disfluent.

1.4 Speech Disfluencies

1.4.1 Theoretical Background

According to Levelt's (1989) speech production model, speech disfluencies can be broken down into two types, microplanning, and macroplanning. Microplanning involves cognitive processes needed for the retrieval of lexical information and encoding of the phonology prior to articulation of specific words. Macroplanning includes the cognitive processes that are involved in semantic or conceptual planning of the direction of the conversation. It is hypothesized to involve two stages that reflect the two parts of the lexical selection system of Levelt's speech production model. These are the selection of communicative goals, and the construction of a macroplan for the communication of those goals (Kirsner & Roberts, 2000). The macroplan provides the framework to achieve the speaker's communicative goals in spoken discourse. The macroplan is assumed to be a supra-phrasal structure, incorporating semantic-conceptual information that may be

expressed over several phrases and sentences. However, if cognitive resources are overwhelmed while an individual must produce speech, then speech disfluencies occur.

Each person's verbal fluency and speech rate varies depending on the context, topic of conversation, his or her internal state, working memory capacity (Khawaja, Ruiz, & Chen, 2008; Merlo & Barbosa, 2010), age (Griffin & Spieler, 2006), and even medication-related side effects (Pakhomov, Marino, & Birnbaum, 2013). Predominantly, the effects of cognitive load on speech are measured in terms of speech disfluencies, which occur if the speaker's speech grinds to a halt or is significantly altered from its fluent baseline. A disfluency is often exhibited through silent pauses. For research purposes, a silent period ≥ 200 ms is often used to define a silent pause (Jameson et al., 2010). Alternatively, a speech pause may occur in a filled form where the speaker introduces non-word verbalizations (e.g., "um...", "er...", "huh..." etc.) to bridge the gap in speech. Other manifestations of speech disfluencies are exhibited through false starts (e.g., "Yeah... Well, no actually..."), repetition (e.g., "I think... I think it would..."), and parenthetical remarks (e.g., "Well, I mean"), increased onset latency, and a reduction in speech rate (Khawaja et al., 2014).

Of particular interest is evidence that speech disfluencies are not a social or linguistic artifacts but are an inherent part of our speech production. In experiments where hesitation pauses greater than 200 ms were "punished", the result was an increase in other hesitation phenomena (Kirsner & Roberts, 2000); showing that speakers have some control over the use of disfluencies, yet are dependent on some combination of disfluencies for managing speech production.

Common strategies for overcoming or reducing speech disfluencies include Easy First, Plan Reuse, and Reduce Interference (MacDonald, 2013). The first two strategies involve retrieval of lexical items and syntactic plans from long-term memory; the last strategy involves the organization of working and short-term memory during speech production. Easy First strategy is a response to the phenomena of words being retrieved from long-term memory at different rates. This strategy involves utilizing word order flexibility to place easily retrieved, or more accessible, words at the beginning of the utterance to allow longer time for the retrieval of more difficult words. The more accessible words are those that are frequently used, shorter, primed, hold personal importance, or are conceptually salient. The Plan Reuse strategy involves the selection of utterances that are frequently used. Contrary to the flexibility of Easy First, Plan Reuse strategy involves the automatization of certain utterances due to their frequent use and high salience. Finally, the Reduce Interference strategy attempts to minimize the number of words that are semantically and phonologically similar. Other strategies that reduce processing load include speech rate reduction, increased use of prosodic pauses, and message forecast macroplanning (Merlo & Barbosa, 2010).

1.4.2 Empirical Evidence for Speech Disfluencies

During speech production, every individual alternates between stages of speech fluency and disfluency, which is referred to as temporal cycles in speech. Original research into temporal cycles was less than empirical. The “Henderson plot”, a technique where the researcher places lines of “apparent best fit” on a graph that denoted the duration of speech and pauses greater than 100 ms (Kirsner & Roberts, 2000, p. 131), was first used to identify temporal cycles in speech. The Henderson plot appeared to take

a stair-like shape, representing an interchanging speed of verbalization. The periods of high speech fluency are referred to as production phases, whereas periods of low speech fluency as preparation phases. The “Henderson plot” was criticized for lacking validity, and failed attempts to replicate the results put the phenomena of temporal cycles under question.

Using modern computational analyses, the phenomena of temporal cycles in speech has been reaffirmed. It appears that temporal cycles do not occur by chance relative to the structure of language or the temporal domain, but rather they appear in an ordered and predictable fashion (Merlo & Barbosa, 2010). It is now widely accepted that temporal cycles occur due to an increase in cognitive load during speech production (Griffin & Spieler, 2006; Merlo & Barbosa, 2010), and are an adaptation for the maintenance of fluency in all speakers.

Periods of high cognitive load are marked by a reduction in speech output rate, as measured by total number of words produced, and speech production rate as measured by syllables over time (Jameson et al., 2010). The reduction in syllables implies a reduction in the complexity of sentences. Furthermore, high cognitive load causes an increase in the onset latency of speech, silent pauses (number and duration), and filled pauses (number and duration). Finally, there is also a reduction in quality of speech, with more repetitions, more sentence fragments, more false starts, and more self-corrections (Jameson et al., 2010).

Dissenting results have also been observed (Khawaja, Chen, & Marcus, 2012; Khawaja et al., 2014). In these studies, participants under high cognitive load produced greater number of total utterances, had reduced onset latency, and had fewer hesitations.

The results were likely due to the social nature of the task in these studies. The researchers assembled teams of highly trained individuals who had to work in a group for the fulfillment of a communal goal, such as organizing bush-fire teams, so the base unit is the group, not the individual. In a scenario such as this, group members under a high cognitive load would be encouraged to “offload” cognitive tasks onto the other team members (see: Dawson (2013) Chapter 5.2, for a discussion of societal/distributed cognition). Furthermore, the smooth functioning of the group in the accomplishment of the collective information processing task would require more communication between individuals. As such, these results are not applicable to the individual-centered research conducted in the present study.

1.4.3 Previous Research on Language Production in Psychopathy

Despite the vast amounts of research on language and psychopathy individually, little research has examined language production and psychopathy together. With regard to language and psychopathy, previous studies have either focused on emotion perception as conveyed by verbalizations (Blair et al., 2002), or conceptual/ reasoning skills in interpreting messages (Kiehl, Hare, McDonald, & Brink, 1999). In either scenario, language is only a representational vehicle, and the content of interest is emotion or concepts, respectively. Of the few studies that have directly attempted to access a psychopath’s linguistic abilities, even fewer have focused on language production. In this section I review empirical evidence in the areas of language perception and production within the psychopathic population.

Psychopaths have difficulty differentiating between abstract and concrete information in lexical decision tasks (Kiehl, 2006; Kiehl et al., 1999). On a Q-sort task, a

task where one must create a continuum from given stimuli based on criteria given by the researcher, psychopaths had significant difficulty categorizing metaphors by their emotional content, even when the metaphor is “unambiguous” (Hervé, Justus Hayes, & Hare, 2003). Furthermore, psychopaths have been found to have difficulty attributing guilt to characters in a story passage (Blair et al., 1995).

Generally, participants have enhanced responsivity to emotional language. However, psychopaths showed significant deviations in emotional processing of emotional faces and emotional vocalizations (Brook, Brieman, & Kosson, 2013; Hervé et al., 2003). Furthermore, whereas a nonpsychopathic individual recognizes emotional words faster than neutral words, individuals with psychopathy fail to show such processing preference (Williamson, Harpur, & Hare, 1991). When asked to identify the emotion of the speaker based on prosody, psychopaths appear to be impaired in the recognition of fearful vocal affect (Blair et al., 2002).

Nonpsychopathic individuals tend to speak more loudly when discussing emotional topics, especially when using emotional words. However, psychopaths speak more quietly and do not place prosodic emphasis on emotional words (Louth, Williamson, Alpert, Pouget, & Hare, 1998). Furthermore, psychopaths, despite being much more likely to commit instrumental violence (defined as the intentional initiation of violence to achieve a goal), are much more likely to describe it in reactive terms (Porter & Woodworth, 2006). This is believed to be due to the general nature of psychopaths’ increased likelihood of deception, even in situations where there is no possible gain from it, possibly due to duping delight (defined as the enjoyment of deceiving others for its own sake).

Individuals diagnosed with antisocial personality disorder (ASPD), a disorder closely related to psychopathy, used more repetitions, pauses, and negations within semi-spontaneous written language production compared to non ASPD individuals (Gawda, 2010). Participants were asked to write stories based on pictures that displayed emotional scenes. Gawda argues that these techniques are tools for persuading the listener. According to Gawda, the use of repetitions, pauses and negations is a way emphasizing certain statements, similar to an experienced orator using these tactics for impact. Although this may be true for written language, due to the increased temporal demands in spoken language, language must remain fluent and rhythmic, any repetitions and pauses observed in non-rehearsed speech are most likely to be the result of attempting to fill speech disfluencies. If observed in statistically greater quantity in psychopathic individuals than non-psychopathic individuals, it would be consistent with the claim that the disfluencies are the result of a poor ability to process emotional language (Kiehl, 2006) or due to attempts to deceive (DePaulo et al., 2003; Vrij, Fisher, Mann, & Leal, 2006). In a follow-up experiment, Gawda (2013) showed that individuals with ASPD used a greater number of emotional words, and words of a greater emotional intensity, than a control group. Most interestingly, she found that the antisocial individuals used emotional words of an inappropriate valence for the situation they were describing. This finding is consistent with previous research showing that psychopaths have difficulties processing emotional conceptual language.

Examining word usage is another way to explore potential differences in language production between psychopaths and nonpsychopaths. Hancock, Woodworth, and Porter (2013) transcribed interviews with individuals incarcerated for murder and found that

psychopaths use a greater number of cause-and-effect descriptors, have a greater focus on physical needs (food, drink, sex, etc.), use distancing language, and have a greater number of disfluencies. Due to their use of transcribed speech, Hancock et al. operationally defined speech disfluency exclusively as filled speech pauses (e.g., um...), leaving much of the phenomena unanalyzed.

1.5 Emotion Perception

Of theoretical interest to the study of emotional language is the relationship between the perception of emotions, their interpretation and subsequent expression in language. In this section, will briefly review two competing models of emotion perception and attempt to draw parallels between these and language production. The first model to be discussed is the standard model of emotion perception, which suggests that emotion perception is an extension, or special case, of the general perception mechanisms. The standard model argues emotion perception to be largely bottom-up in nature. The alternative view is the Theory of Mind (ToM), which does not deny that emotion perception requires proper perception as such, but argues that perception is a very low-level phenomenon and it is the interpretation and contextualization of the emotion that is crucial for the emotion perception process. ToM proponents suggest that emotion perception is predominantly a top-down phenomenon. Although most recent models of emotion perception attempt to synthesize the standard model and ToM, there is little agreement about how the two models combine, and which is the dominant component in everyday emotion perception tasks.

1.5.1 Standard Model of Emotion Perception

The standard model of emotion perception suggests that emotions are perceived much like all other sensory perceptions. Although the perception of emotions is more complex than the simple perception of colour, for example, all the added complexities are the result of extra processing systems built onto the basic perceptual modalities. The brain is an organ that, among many other complex tasks, is responsible for the perception of the world. Although our perceptual systems are highly complex, they have been studied by psychologists for the last 150 years, since the days of Fechner, and the basics of the perceptual systems are quite well understood. Details can be gleaned from any number of introductory textbooks in perception (e.g. Chaudhuri [2011]). The standard model of emotion perception suggest that emotions are transmitted, or communicated, between individuals through the means of physical symbols (Ekman, 1993, 2003) which then are associated with the appropriate category.

Once visual information from the outside world is in the neural system the information must pass along the dorsal and ventral streams to the Lateral Geniculate Nucleus (LGN) and then primary visual cortex. Emotion perception is believed to be conducted via the slow cortical channel of the visual cortices and a yet unconfirmed fast subcortical channel probably the LGN. The LGN is the most pertinent of the two areas to emotion perception because this area is believed to be the best candidate to be a shortcut to the amygdala for emotion processing (Diano, Celeghin, Bagnis, & Tamietto, 2017). However, evidence is still lacking for a specific pathway that allows for this connection (De Cesarei & Codispoti, 2015). Nonetheless, the fact that neuroscientists have not yet found the specific neural pathways for the “shortcut” to emotion perception does not

eliminate the ample evidence that a visual subcortical pathway to the amygdala exists (LeDoux, 1996), creating what appears to be a dual stream system for processing objects and emotions (Haxby, Hoffman, & Gobbini, 2002), with object being processed by various visual cortices, and emotions being processed by the amygdala.

Evidence from multi-modal emotion perception tasks makes it clear that emotion perception occurs within the first 100 ms of stimulus onset (Pourtois, de Gelder, Vroomen, Rossion, & Crommelinck, 2000). When presenting conflicting stimuli through the auditory and visual perception pathways, the N1 event-related potential (ERP) can be detected at around 100 ms. The N1 ERP only occurs when incongruent emotions are present, but does not appear during congruent (or unimodal) emotional stimuli presentations suggesting that the N1 ERP signals the brain's activation of extra resources to disambiguate the contradiction. This evidence suggests that both the audio and the visual modalities have already been able to process the emotional valence of the stimuli at around 100 ms. After detection of emotional incongruence, a greater activation of the fronto-parietal network can be observed and is believed to be involved in disambiguation of the conflicting emotional stimuli and reallocation of attentional resources as needed (Mitchell, 2007). This attentional capture is an involuntary effect of emotion perception that only occurs after there is evidence of important information, such as an emotional face, which can only occur once we have perceived the emotion. This salient information, in most people, should activate the Salience Network (Schirmer & Adolphs, 2017). Individuals who may be able to detect emotions, but have problems with the activation of the Salience Network, would exhibit symptoms similar to individuals with Autism Spectrum Disorder (ASD), who are believed to have a dysfunctional Salience Network

(Green, Hernandez, Bookheimer, & Dapretto, 2016; Toyomaki & Murohashi, 2013; Uddin et al., 2013). The difficulty with the Salience Network that ASD individuals experience is thought to explain why they exhibit social adjustment problems that are disproportional to their emotion perception difficulties.

Another line of reasoning that is brought up as an argument for the standard model of emotion perception is facial mimicry of emotions. Emotion mimicry is an involuntary process that most healthy humans perform (Kirkham, Hayes, Pawling, & Tipper, 2015; Ponari, Conson, D'Amico, Grossi, & Trojano, 2012). Facial mimicry is the involuntary activation of facial muscles in a pattern that stereotypically resembles the prototypical emotion that is being perceived. According to the matched motor hypothesis (Goldman & Sripada, 2005), the movements in the face are spontaneously copied, independently of the intentions of the observer or expresser. This is believed to be the result of the activation of mirror neurons (Decety & Jackson, 2004; Goldman & Sripada, 2005). Mirror neurons activate when an individual is observing the actions of others and are believed to be a fundamental mechanism of learning. Emotional mimicry is a special type of behavioural mimicry that allows us for a better understanding of others, and is the foundational mechanism for what we call “empathy” (Lakin, Jefferis, Cheng, & Chartrand, 2003). It has been observed that individuals where the normal pattern of facial mimicry is disrupted have difficulty in their personal and social lives (Ziebell, Collin, Weippert, & Sokolov, 2016).

1.5.2 Theory of Mind

Although the argument that emotion perception is a special type of perception in general is highly alluring, it does have a challenger in the Theory of Mind (ToM) camp.

The ToM side suggests that even though we rely on perception to understand emotions, and there may be some rudimentary perception specific to emotional content, it is the interpretation of emotions that matters most. ToM, unlike perception, is a learned ability and any handicap in ToM leads to major social debilitation, whereas deficits in perception do not. ToM proponents would argue that it is incorrect to say that we “perceive” emotions, since it is the interpretation of emotions that plays the crucial role in our lives.

Research in ToM can be traced as far back as the seminal work of Heider (1958) on people’s mentalizing about other’s minds. However, the current form of ToM is typically attributed to Premack and Woodruff (1978) who defined ToM as the ability to make predictions about the behaviour of others based on the understanding of their mental states and motivations. Simply put, a ToM allows a person to predict the behaviour of others based on an understanding of their internal mental states. In a related field of “social cognition”, Brothers (1990) suggested that interpretation of facial expressions is a vital part of understanding other’s intentions, suggesting that perception of emotional faces is subsumed by the overarching cognitive structure of ToM. Lending support to the argument that facial expressions are crucial to the interpretation of other’s emotional states is the Reading the Mind in the Eyes Test (Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001). In the Reading the Mind in the Eyes Test subjects are instructed to identify mental states from photographs of the eye region only. This test is one of the most popular tests for determining impairments in ToM reasoning in adults and has been shown to successfully discriminate between individuals on the Autism Spectrum, and healthy controls, however, psychopaths were not found to have

deficiencies on this test, but were better than their non-psychopath peers (Nentjes, Bernstein, Arntz, Breukelen, & Slaats, 2015).

ToM deficiencies are believed to be a result of poor integration of the medial frontal gyrus, the anterior paracingulate, and the right temporoparietal junction (Kana, Keller, Cherkassky, Minshew, & Just, 2009) as well as the amygdala (Mier et al., 2010; Schmitgen, Walter, Drost, Rückl, & Schnell, 2016). Although, there is overlap between brain regions that are utilized for emotion perception tasks and those that are utilized in ToM, there are crucial distinction between ToM and the standard model of emotion perception.

The largest difference between emotion perception and ToM is the ontogenesis of the ability. Emotion perception is believed to be largely inborn, and therefore, develops extremely early (Grossmann, 2010). For example, infants can discriminating emotional faces at 3.5 months (Montague & Walker-Andrews, 2002), or possibly earlier, and at 6.5 months infants are able to differentiate between emotional postures of adults (Zieber, Kangas, Hock, & Bhatt, 2014a, 2014b). In contrast, ToM skills develop much later in life (Calero, Salles, Semelman, & Sigman, 2013; Frith & Frith, 2001). ToM development is even believed to stretch into late adolescence (Dumontheil, Apperly, & Blakemore, 2010). This suggests a distinction between “situational” and “cognitive” based emotions (Harris, 1989); or “simple” and “complex” emotions. Situational emotions would be basic emotions that do not require the understanding of an actor’s specific beliefs about the situation, for example, the expression of fear in the presence of a predator. However, cognitive emotions would require the understanding of an individual’s beliefs to be

interpreted; for example, embarrassment cannot be understood outside of context (Golan, Baron-Cohen, & Hill, 2006).

Most importantly, individuals who have moderate to severe social impairments also perform poorly on ToM tasks. For example, schizophrenia patients and individuals who are seen as “at risk of clinical schizophrenia” have been found to have impaired ToM reasoning abilities (Barbato et al., 2015). Individuals on the Autism Spectrum are also impaired in their ability to reason in ToM tasks (Baron-Cohen, Leslie, & Frith, 1985; Kana et al., 2009; Rutherford & McIntosh, 2007; Walsh, Creighton, & Rutherford, 2016). Furthermore, some individuals have no problems with emotion perception but have a strong impairment in ToM tasks (Barbato et al., 2015) such as those with subclinical schizophrenia. Other individuals have difficulty with emotion perception (Blair & Mitchell, 2009; Blair et al., 2002; Blair et al., 1995; Marsh & Blair, 2008), but not with ToM tasks (Dolan & Fullam, 2004; Nentjes et al., 2015), such as psychopaths. Therefore, ToM deficits are argued to lead to profound problems for individuals in the real world, and improvements in ToM skills leads to an improvement in everyday functioning (Gupta, 2015), whereas emotion perception leads to skewed, but not impaired, social functioning.

Furthermore, ToM proponents argue that many studies conducted on emotion and language perception cited as evidence for bottom-up models of processing are not environmentally valid, so incorrect conclusions are often made. These studies typically present hundreds of randomized trials and after averaging over several categories (or experimental conditions) “determine” how stimuli are perceived (Jessen & Kotz, 2013). Furthermore, a recent literature review showed that facial mimicry is not a simple

stimulus-response that we model, but is dependent on the social context (Hess & Fischer, 2014), where we will not mimic emotional expressions of strangers, and will only perform the mimicry in a social context that promotes our group affiliation.

In general, the distinction between perception and cognition is starting to be washed away by recent findings that suggest a surprising amount of top-down control on our perceptions (Balcetis & Dunning, 2006; Collins & Olson, 2014). Emotion perception can be successfully primed by preceding language (Barrett, Lindquist, & Gendron, 2007) and emotions (Skuk & Schweinberger, 2013). There is even some evidence to suggest that participants are able to interpret irony and sarcasm within 200 ms given pragmatic knowledge about the topic (Regel, Coulson, & Gunter, 2010), suggesting that much of our understanding of emotions and surroundings is based on forward modelling and predictions about our environment, which interact with the incoming sensory input and together this accounts for our perceptions. Even most types of modern psychotherapy, such Cognitive Behavioural Therapy, are built up on the assumption that our belief structure has a direct impact on our perception and interpretation of our surroundings.

Most current models of emotion perception include some form of interaction between perception and interpretation (see Mitchell and Phillips [2015] for a review). However, agreement typically stops there, since none of the theories are able to agree on which system is the main driver of emotion perception, or which system is responsible for what aspect of perception. For example, Newen, Welpinghus, and Juckel (2015) proposed a theory that includes a dual mechanism for perception of emotions, with both bottom-up and a top-down components. This model suggests that we have direct perception mechanisms, and inferential mechanisms for emotion perception. According

to Newen et al., the first is directly linked to the perceptual systems and the latter directly linked to Theory of Mind. They conclude that we are able to perceive emotions in three different ways: first, direct perception with minimal top-down processes; second, direct perception predominantly involving top-down processes (but no inferences); and third, inference-based recognition of emotion.

1.6 Summary

In summary, when studying a specific phenomenon such as emotional language production in psychopathic individuals that spans three large areas of research –forensic psychology, psycholinguistics, and emotion cognition – it is paramount to have a strong theoretical foundation to help draw parallels and arbitrate contradictions between different fields. Thus far, I have briefly reviewed the prominent theories of psychopathy, language production and emotion perception. I have also reviewed some relevant literature on language production in psychopathy. It seems clear that individuals high in psychopathy have aberrant language and emotion perception abilities. However, it is less clear that individuals high in psychopathy scores have no ToM deficiencies (Dolan & Fullam, 2004; Nentjes et al., 2015). Because there is only a small body of literature on psychopathy and ToM, it is possible that the two studies may have been subject to a ceiling effect, or used a task that did not pose a challenge to the high psychopathy population, and were simply not able to discriminate any present deficiencies. Alternatively, if the ToM studies in the psychopathic population were accurate, and the psychopathic individuals really aren't deficient in ToM, then this would explain why psychopaths are often described to “know the words, but not the tune” to account for knowing *about* emotion but not necessarily being able to *experience* emotion. In the

context of speech production, psychopathic individuals know “all the right words” to describe an emotion, but do so in a way that does not paralinguistically convey the emotion appropriately through the use of tone, prosody, etc. This interpretation suggests that the paralinguistic aspects of language production (in other words: the form) are inherently connected with emotion perception; whereas the production of the language itself (in other words: the content) is related to the ToM.

The two studies conducted as part of this thesis attempt to shed light on the phenomenon of language production in the psychopathic population. Although neither of these studies directly tests ToM, they both attempt to compare the distinction between the form and content of speech within the framework of psychopathic personality traits. The first study is an exploratory view of language and its relationship to psychopathy, as well as the relation of disfluencies to language production. The second study attempts to replicate some of the results of study one using interviews with an incarcerated population.

It was expected that in Study 1 psychopathy scores of the participants would be associated with low verbal fluency, as measured by the number of silent and verbalized disfluencies, and the production of inappropriate emotional content (e.g. joy at a funeral). This hypothesis is justified by the absence of motivating factors (participants produced fictional monologues in a sound-isolated booth). Motivation has been theorised to be a critical component for the adequate functioning of psychopathic individuals’ cognitive processes. Alternatively, Study 2 sampled psychopathic individuals’ speech under a higher motivation condition. Because of the change in motivation, and reduced difficulty of the task (recall in an interview setting), fluency was not expected to be associated with

psychopathy scores, however, higher psychopathy scores were expected to predict increased emotional content of language.

2 Chapter: **Study 1**

Spontaneously generating and verbalizing a fictitious story is a highly demanding cognitive task. Within the framework of dual-process models, story generation is in the domain of the newer cognitive system that requires use of “secondary knowledge” and high abstraction. Alternatively, the production of speech itself is a fast, automatic task that is performed by the older specialized system. As the load on the conceptual system is increased, and possibly overloaded, the speech production system becomes starved for cognitive resources and conceptual material for verbalization. As a result, compensation techniques are implemented to maintain perceived fluency, such as speech disfluencies and the use of simpler language. As noted earlier, speech disfluencies consist of two types: 1) silent speech disfluencies are unintentional disruptions of speech, longer than 200 ms and 2) verbalized disfluencies include “um” and “uh”. It follows that individuals who have some hindrance in the conceptual system would exhibit evidence of the hindrance through silent speech disfluencies and a reduction in the complexity of words produced. The literature review in Chapter 1 suggests that psychopathic individuals are prone to difficulties processing emotional and linguistic content, as such it is to be expected that a task that activates both the linguistic and the emotional processes will cause greater cognitive load for individuals who are higher in psychopathy, compared with those who are low. Therefore, an initial hypothesis would be that individuals who are high in psychopathy traits will produce a greater number of disfluencies and other paralinguistic factors that suggest burdened language production, than those who are low in psychopathy.

The present exploratory study attempts to determine if personality traits related to psychopathy can predict increased cognitive load during spontaneous speech production 1) while recalling a recent event from memory and 2) while constructing a fictitious story. Two factors are of particular interest: the emotionality and fluency of the stories. Fluency are measured by silent pauses, as well as the presence of verbalized filler disfluencies. Emotionality of the stories will be measured using an analysis of the story content, as well as peer evaluation. This study was motivated by the desire to replicate and expand the findings of Hancock et al. (2013) and Gawda (2010).

Methodologically, it is of interest to examine if the open-ended nature of Gawda's (2010) experiment, where participants wrote stories based on a visual stimulus, could be replicated via requiring a spoken response instead of a written response. Similarly, it is of interest to see if Hancock's et al. (2013) findings would be replicated if participants were to provide fictional, as opposed to recollected, stories. Therefore, an attempt was made to blend the methods used by Gawda and Hancock et al., where participants were presented with six emotionally charged scenes corresponding to the primary emotions proposed by Ekman (2003), and were instructed to produce 4 minute stories as if they were a character in the scene.

I introduced major changes in methodology and analysis compared to these previous studies. First, because they focused on analyzing written responses, neither Gawda (2010) nor Hancock et al. (2013) identified silent disfluencies. Second, both studies either transcribed (Hancock et al., 2013) or analyzed (Gawda, 2010) the language produced by their sample manually; this study replicates the transcription, but adds an element of computational speech signal analysis and content analysis, reducing the

subjective component of the response measures. Furthermore, participants in Study 1 were from a subclinical population, not a clinical population. Finally, Study 1 contrasts stories that are thought to be truthful (i.e., recalled from memory) and stories that are thought to be fictional. Given this distinction, I should be able to determine if the extra cognitive load of creating a fictional story, compared to a recollection of an actual event, will allow for a greater differentiation between the high psychopathy participants, and the low psychopathy participants.

2.1 Method

2.1.1 Participants

41 Carleton University undergraduate students volunteered to participate. From this original group, 7 participants were removed due to not following instructions, leaving 34 participants (20 female, 14 male) with a mean age of 20.9 ($SD=7.4$) years. For this study only participants who were deemed to be not following the instructions, for example describing the stimuli instead of verbalizing a story around it, were removed from the analysis. This is justified by the exploratory nature of the research, where the intent is to capture maximum variation, including extreme scores.

Of the remaining participants a large subset ($N=30$) had the stories they produced transcribed verbatim. Four participants were excluded based on the reduced quality of the recording. All participants were recruited through the university's online study participation system and self-identified English as their primary language. Participants received course credit in exchange for participation.

Another 365 participants (257 female) average age 20.5 ($SD=4.39$) performed peer ratings using the Qualtrics online survey platform (Qualtrics, 2016) on the stories produced by the first group.

2.1.2 Measures

Participants from the first group completed the International Personality Item Pool (IPIP) Big 5 Personality traits questionnaire (Goldberg, 1999). This is a 50-item questionnaire developed to measure general personality traits (openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism). It is comprised of statements (e.g., “I am the life of the party”) that are scored on a 5-point Likert scale from Strongly Disagree (1) to Strongly Agree (5). The Big 5 was found to have good internal consistency, and convergent reliability (Gow, Whiteman, Pattie, & Deary, 2005).

The Self-Report Psychopathy Scale III (SRP-III) (Williams, Paulhus, & Hare, 2007) short version was administered. The SRP-III short version is comprised of 29 questions (e.g., “I like to watch fist fights”) that are scored on a 5-point Likert scale from Strongly Disagree (1) to Strongly Agree (5). The results are scored on four dimensions of Interpersonal Manipulation, Callous Affect, Erratic Lifestyle, and Criminal Tendencies, with individual factor scores given in addition to a total SRP score. The SRP-III has been found to accurately predict PCL-R scores in incarcerated populations (Tew, Harkins, & Dixon, 2015), as well as being closely associated with other leading scales that measure traits associated with psychopathy (e.g.: bullying, right-wing extremist attitudes, etc.) in community samples (Gordts, Uzieblo, Neumann, Van den Bussche, & Rossi, 2017).

Participants also completed the Behavioural Inhibition and Behavioural Approach Scales (BIS/BAS) (Carver & White, 1994; Gray, 1987). The BIS/BAS is a tool for

measuring the psychological construct of disinhibition, which subsumes the constructs of distractibility, impulsivity, irresponsibility, and risk taking. These personality traits are associated with mechanisms for controlling behaviour that involves seeking out reward that is associated with positive emotions versus behaviour that avoids punishment, associated with anxiety. This 24-item scale asks participants to rate how much they agree or disagree with statements (e.g., “I will often do things for no other reason than that they might be fun.”) on a 4-point Likert scale from 1 (very true for me) to 4 (very false for me). The BIS/BAS scale is one of the most widely used scales for self-report measures of behavioural approach and behavioural inhibition. Although this scale has received adequate validation from some researchers (Heubeck, Wilkinson, & Cologon, 1998; Leone, Perugini, Bagozzi, Pierro, & Mannetti, 2001), more recently, researchers raised questions about the validity of the current factor structure, and have recommended removing some questions, or a total restructuring of the scale (Cogswell, Alloy, van Dulmen, & Fresco, 2006; Levinson, Rodebaugh, & Frye, 2011). Nonetheless, the scale is generally deemed to be accurate, and it is widely used in the literature.

Finally, participants completed a working memory task. Working memory capacity was measured using a version of the reading span (RSPAN) task adapted from Turner and Engle (1989). This measure assesses an individual’s ability to maintain and retrieve task relevant information in active working memory stores while attention is focused on performing an unrelated simple yet nontrivial cognitive task. In this version of the RSPAN task participants were presented with a series of sentences in both auditory and visual form. Participants were required to repeat the sentences. Each sentence was followed immediately with a letter to be recalled following the presentation of a span of

two to five sentences. Participants were asked to make judgments after reading each sentence and letter pair regarding whether the sentence was semantically correct. Once a span of two to five sentence-letter pairs was presented participants were asked to recall the letters from the set in the order they were presented by writing them down on a response sheet. This dual-task methodology is the traditional method of assessing working memory load (Sweller et al., 2011). The working memory task has been found highly reliable and stable based on test-retest methodology (Klein & Fiss, 1999).

Working memory capacity was measured because previous empirical and theoretical work linked working memory capacity with verbal fluency (See Section 1.3.2 for more information). As such, working memory capacity was viewed as a potential confounding variable. The Big 5 and BIS/BAS questionnaires were administered to the participants for the purpose of an unrelated study and were not used in the analysis.

2.1.3 Stimuli

Visual stimuli consisted of six images (Appendix A) depicting the emotional categories of anger, happiness, fear, disgust, surprise, and sadness. All images were available in the public domain.

2.1.4 Procedure

The participants from the first group were tested individually in a sound-isolating booth. All instructions, stimuli, and questionnaires were presented on a PC using PsychoPy software (Peirce, 2007). Participants' speech was recorded using a headset microphone and Audacity software (Audacity-Team, 2016). Each recording session was preceded and succeeded by a one-second tone denoting the onset and offset of each recording session.

After completing consent forms and receiving brief instructions for the study, participants entered the sound isolating booth and were instructed to verbally provide a 2-minute recollection about their day, or any recent memory they have. After the recollection phase, participants were sequentially presented with the six emotional scenes (Appendix A) in a fixed order corresponding to angry, disgusted, happy, sad, scared, and surprised. For each image, participants were asked to imagine they were in the scene, and “tell a story about what is happening and what they are feeling”. Each image was presented for only 10 seconds, followed by a tone to denote the onset of the recording and then a countdown timer from 4 minutes replaced the image, finishing with another tone to mark the end of the recording. After the 7 recording phases (1 baseline recent memory, and 6 emotions) participants were presented with the three self-report questionnaires in the following order: 1) IPIP Big 5 personality traits, 2) SRP-III, and 3) BIS/BAS. Participants marked their responses using the mouse on the computer screen. Finally, participants were instructed on, and performed the working memory task. The entire procedure required approximately 75 minutes to complete. Once participants completed the tasks, they were debriefed about the goals of the study.

Peer-ratings were performed by participants who rated each story on a 5-point Likert scale (1 = “Not at All” and 5 = “Very”) on the presence of the 6 basic emotions in the story, overall emotional intensity of the story, how entertaining the story was, overall quality, and truthfulness of the story. Participants did not have a maximum time limit for completion, however, participant’s ratings were removed if they did not spend a minimum of 20 seconds per story on the web-page. Peer-raters received course credit for their participation.

2.1.5 Analysis

2.1.5.1 Speech Data

Speech signal data were first manually segmented using Audacity software (Audacity-Team, 2016) to represent the different emotional categories. Audio segments were trimmed to two minutes in length to allow for inclusion of those participants who produced stories that were less than 4 minutes in length, and to be able to compare the fictional stories with the recollected stories. A total of 476 minutes of audio recording was analyzed. The recordings were subjected to high-pass and low-pass band filters of 500 Hz and 1 kHz, respectively, to remove non-speech artifacts. Praat software (Boersma & Weenink, 2016) was used to analyze the speech. Silences were measured by a modified version of a Praat script, originally created by Lennes (2017), set to detect silences with duration greater than 200 ms and intensity lower than 45 db. The 200 ms criterion for silent disfluencies was based on work by Jameson et al. (2010). Speech samples with less than 60 seconds of speech or fewer than 50 pauses detected were manually reviewed. A decision was then made to accept the results, or to reconfigure the intensity threshold of silence. Typically, the results were accepted, but some soft-spoken participant's recordings were reanalyzed with a threshold of 30 db. Following this, custom Visual Basic scripts were used to segregate micro-pauses of duration between 200 ms and 500 ms and macro-pauses of duration >500 ms. Measurements of three factors were extracted from the speech signal for each participant's story: total duration of silence, average duration of each silent pause, and number of pauses. Syllables were counted using the Syllable Nuclei Praat script (de Jong & Wempe, 2009)

2.1.5.2 Speech Content

Speech from the 30 participants was transcribed verbatim. The filled disfluencies “um”, “uh” and “so” were counted in each story. Furthermore, the number of words produced, speech rate and the number of polysyllabic words produced were also counted. For each word a rating of emotionality, frequency and rank were assigned using custom Visual Basic scripts. The emotional valence of words was obtained from the NRC Emotion Lexicon (National Research Council Canada, 2011). Frequency and rank values for all the words were assigned according to the Frequency Words list for 2016 OpenSubtitles dataset (David, 2017). The truncated version containing fifty thousand most frequent words was used in this analysis. The OpenSubtitles dataset was chosen over some of the more traditional frequency lists because it is based on television transcripts, which are a much closer approximation of spoken language than frequency lists based solely on written texts.

2.2 Results

2.2.1 Gender Differences in Language and Psychopathy

Male participants, on average, had higher SRP scores ($M = 56.1$, $SD = 15.7$), compared to females ($M = 47$, $SD = 19.4$) (see Appendix A for descriptive statistics). However, this difference was not statistically significant ($F(1, 33) = 2.10$, $p = .158$), supporting the argument that gender differences in psychopathy did not significantly affect the results.

2.2.2 Disfluencies

2.2.2.1 Verbalized Disfluencies

A total of 2,442 verbalized disfluencies were observed, making them the 3rd most frequent utterance after “I” and “and”. Individually, “so” ranks 6th most frequent, “um” follows with a ranking of 10th, and “uh” is ranked as the 15th most frequent word in the corpus. Because the disfluency data was not normally distributed due to the presence of outliers, Spearman’s rho was chosen for the analysis.

The “um” disfluency was positively correlated with syllables per word produced ($r_s = .48, p = .011$) (see Table 1 for a summary of correlational results); and the number of polysyllabic words produced as a function of all words ($r_s = .48, p = .008$). The number of “um” utterances was not significantly correlated with working memory capacity. No significant correlations were found between the production of “um” and the production of other disfluencies.

The “uh” disfluency was non-significantly positively correlated with the rate of speech production ($r_s = .31, p = .103$), defined as syllables produced per second of speech. No other significant or non-significant correlations were observed for the “uh” disfluency.

Table 1:

Correlations between disfluencies, individual and linguistic factors

	1	2	3	4	5	6	7	8	9	10	11
1 Um											
2 Uh	.103										
3 So	-.125	-.160									
4 Age	.387*	.231	-.223								
5 Working Memory	-.405*	-.308	.143	-.551**							
6 # of Words	-.017	.135	.599**	.222	-.112						
7 Syllables/ Words	.479**	-.126	.036	.111	-.323	.121					
8 Polysyllabic Words	.321	.094	.490**	.283	-.231	.807**	.529**				
9 Polysyllabic/ Words	.567**	-.063	-.038	.165	-.216	-.119	.712**	.482**			
10 Speech Rate	-.131	.378*	.366	-.017	-.197	.730**	.226	.572**	-.097		
11 Macro-Pause	-.295	.221	-.435*	-.338	-.011	-.629**	-.114	-.624**	-.088	.041	
12 Micro-Pause	.248	-.042	.179	.270	-.119	.711**	.377*	.696**	.090	.513**	-.566**

*Note * $p < .05$, ** $p < .01$; These values are not adjusted for family-wise error

The “so” disfluency was positively correlated with the total number of words produced ($r_s = .54, p = .003$), and number of polysyllabic words produced ($r_s = .45, p = .014$). A negative correlation was observed between “so” and the total sum of macro-pauses produced ($r_s = -.46, p = .012$). Furthermore, when taken as a function of the number of words produced, “so” was negatively correlated with the number of unique words produced as a function of all words produced ($r_s = -.70, p < .001$), and the ratio of non-common words¹ produced ($r_s = -.58, p = .001$) as a function of all words produced. A regression analysis found that “so” was a significant predictor of the number of words produced ($F(1, 28) = 15.13, p = .001, R^2 = .36, R^2_{Adjusted} = .34$). Note that for any analysis

¹ Non-common words were defined as all words with the exclusion of the 100 most frequently used words in the OpenSubtitles database.

of disfluencies compared to words produced, disfluencies were removed from the corpus such that they would not bias the analysis.

2.2.2.2 Silent Disfluencies

Micro-Pauses. The number of micro-pauses (200-500 ms in duration) was positively correlated with the number of words produced ($r_s = .72, p < .001$), the number of unique words produced ($r_s = .74, p < .001$), polysyllabic words ($r_s = .69, p < .001$), non-common words ($r_s = .60, p < .001$), and speech rate ($r_s = .55, p = .002$). A negative correlation was observed between the frequency of micro-pauses and the total sum length of macro-pauses (>500 ms) ($r_s = -.59, p < .001$).

Macro-Pauses. The number of macro-pauses was negatively correlated with the “so” disfluency ($r_s = -.46, p = .012$). No other significant relationships were found that do not have a direct relationship with the statistical probability of word production.

2.2.2.3 Working Memory

Working memory was non-significantly negatively correlated with age ($r_s = -.26, p = .14$). No significant correlations were found between working memory and disfluencies or other linguistic markers.

A regression analysis was performed to examine the variance that working memory accounts for with regard to verbalized disfluencies. Working memory was found to significantly predict the sum of “um” and “uh” disfluencies ($F(1, 27) = 8.29, p = .008, R^2 = .24, R^2_{Adjusted} = .21$). When disfluencies were analyzed individually, working memory was found to significantly predict only the “um” disfluency ($F(1, 27) = 5.30, p =$

.029, $R^2 = .16$, $R^2_{Adjusted} = .13$). Working memory was not found to predict the production of micro- or macro-pauses.

2.2.2.4 Word Frequency

All the words immediately following a verbalized disfluency, with the exclusion of articles such as “the” “a” and “an”, were segregated into subsets. All the words were assigned a rank and frequency from the OpenSubtitle Database (David, 2017) using custom Visual Basic scripts. All frequency values were transformed using a logarithmic transformation, and a regression analysis was done using Minitab 17 (Minitab, 2014). The whole corpus deviated significantly $\beta = -1.286$ from the ideal of $\beta = -1$, implying a significant overuse of frequent words. Furthermore, the regression coefficients for the words that immediately follow disfluencies were found to be $\beta = -.982$ for “so”, $\beta = -1.050$ for “uh”, and $\beta = -1.057$ for “um”. The degree of confidence for all the slopes was $p = 0.000$; this was expected because the test variables were a subset of the corpus (see Figure 1). This result suggests that the words immediately following a disfluency was of greater complexity and/or rarity than the average of the corpus. Furthermore, the frequency rank of the words adjacent to disfluencies was also calculated. Words immediately after the disfluency “so” had a median rank of 15; “um” had a median rank of “18”; and “uh” had a median rank of 32. These rankings roughly correspond to the changes of the slope mentioned above.

Figure 1: Regression Lines Showing Frequency and Rank Interaction Between Disfluency and Corpus

2.2.3 Recall Compared To Fiction

One of the primary goals of this study was to determine if the added cognitive load of creating a fictional story affected HP individuals' verbal fluency differently than LP individuals' when compared to the truthful recall. As such a series of within-group and between-group analysis were conducted. No significant differences were observed within the LP group when switching between truthful recall and fictional story telling for the factors of: the number of disfluencies (silent or verbalized), words produced, or the number of polysyllabic words produced. Furthermore, no significant differences were observed between the HP and the LP group in the truthful recall condition with regards to the aforementioned categories. However, congruent with my hypothesis, group differences emerged between the HP and the LP groups when the fictional stories were

compared. Furthermore, within group differences appeared within the HP group when they switched between truthful recall and fictional stories.

Specifically, the HP group had a significant increase in silence when switching from the recall story to fictional stories, $t(16) = -2.35, p = .016$ and a significant increase in the duration of each silent pause between recall and fictional stories, $t(16) = -2.17, p = .023$ (see Figure 2). The HP group had a significant decrease in the number of words produced between true ($M = 311.7, SD = 76.9$) and fictional stories ($M = 274.5, SD = 75$);

Figure 2: Sum of silent disfluencies in 2 minute stories. Error bars correspond to 95% confidence intervals.

$t(16) = 2.82, p = .007$. Psychopathy scores were negatively correlated with the number of polysyllabic words produced as a function of total word production ($r_s = -.45, p = 0.012$) (see Figure 3). When polysyllabic words were viewed in terms of group differences within the truthful and fictional categories, no significant group difference was observed between LP and HP in the recollection condition. However, group differences emerged in the recall condition with the HP group significantly reducing the number of polysyllabic

words produced compared to the LP group [$F(1, 29) = 10.99, p = 0.003$], while the LP group experienced a minor decline when transitioning between the recall and fiction.

Figure 3: Correlation showing the relationship between SRP scores and the production of polysyllabic words as a function of all words produced. $r^2_{Linear} = 0.318$

For verbalized speech disfluencies, the HP group preferred “uh” while the LP group preferred “um” (see Figure 4). When spoken disfluencies of “um” and “uh”, relative to the total number of words produced, were taken as a difference of each other, a moderate correlation was observed between the composite variable and psychopathy scores where psychopathy scores were positively correlated with an increasing number of “uh” produced ($r = .42, p = .012$). An incidental finding of a positive correlation was observed between disfluencies and individuals low in behavioral inhibition (BIS), a construct related to psychopathy (Newman, MacCoon, Vaughn, & Sadeh, 2005; Strickland, Drislane, Lucy, Krueger, & Patrick, 2013), with individuals high in BIS

tending to produce a far greater number of “um’s” ($r = .43, p = .014$). Both of these

Figure 4: Verbalized disfluencies as a function of all words produced. Bars indicate 95% confidence intervals. Error bars correspond to 95% confidence intervals.

continued to be observed, but lost significance, if the difference was viewed as a ratio for both SRP ($r = -.33, p = .072$), and BIS ($r = .31, p = .094$).

When disfluencies were viewed within the framework of truthful and fictional stories, no significant differences were observed in the HP and the LP group for the truthful recall condition for the “uh” disfluency. However, group differences emerged in the fictional category with the LP group producing a greater number of “um” disfluencies approaching significance during the recollection phase [$F(1, 29) = 3.82, p = .061$]. Furthermore, the LP group produced a significantly greater number of “um” disfluencies in the fictional story phase [$F(1, 29) = 5.31, p = .029$]. No significant group differences were observed for the “uh” disfluency during the fictional story condition.

To further explore the finding that the HP group's fluency suffered due to the added cognitive load of creating a fictional story, I modeled the rank and frequency of all the words produced by the HP and the LP groups in both conditions. For this analysis, articles and disfluencies were removed from the corpus. The recollection phase showed virtually no distinction between the regression slopes of the HP ($\beta = -1.008$) and the LP ($\beta = -0.995$) groups. However, contrary to our prediction, a model of the fictional stories showed that the HP group had a smaller deviation ($\beta = -1.208$) from the ideal of -1 than the LP group ($\beta = -1.243$), suggesting that the set of words they produced are a more optimal conveyer of information (Zipf, 1950).

2.2.4 Emotional Lexicon

2.2.4.1 Natural Language Processing

Aside from measuring the fluency of the speech of the participants, based on the work of Gawda (2010, 2013), I hypothesized that the HP group would produce stories of a greater emotional intensity, but the emotional valence will be less appropriate for the stimuli (e.g., being happy at a funeral). Furthermore, based on previous findings suggesting that HP individuals have difficulty perceiving fear, I expected to see the largest difference in this emotional category.

For this analysis, the emotional valences were obtained from the NRC Emotional Words Database (National Research Council Canada, 2011). Using custom Visual Basic scripts, words from the transcriptions were matched with the appropriate emotional tokens from the database. In most cases, each emotional word had several emotional tokens associated with it. There are two reasons for this: first, a word frequently contains

mixed associations even in a clear context; second, the words were not pragmatically disambiguated within the context, and as such could have non-standard meanings (e.g.: “that was a killer joke!”). Furthermore, the words of the corpus were not stemmed to help reduce the already present ambiguity; for example the word “kill” and “killer” carry different connotations, as such, it would have been inappropriate to stem the words without some form of disambiguation. The NRC Emotional Words Database partially accounts for ambiguities by including several iterations of base words, such as “happy” and “unhappy”. Furthermore, during the construction of the database, raters were asked to include the ratings for a word under all possible contexts.

Congruent with our hypothesis the HP individuals produced a significantly greater number ($M = 32.5$, $SD = 5.7$) of emotional tokens in the recollection condition compared to the low psychopathy (LP) group ($M = 24.2$, $SD = 4.9$); $t(28) = 1.86$, $p = 0.037$ (see Figure 5).

Figure 5: Boxplot showing the distribution of emotional tokens produced by HP and LP groups under different emotional conditions.

A one-way ANOVA was used to determine if the HP group produced more inappropriate emotions than the LP group. Emotional appropriateness was operationally defined as the ratio of target emotional tokens and the sum of the other five emotional tokens. However, contrary to my hypothesis, no significant group or individual differences were present in the intensity or the appropriateness of the emotions produced between the HP and the LP groups, with the exception of the fear condition where, once

again, contrary to my hypothesis, the HP group produced significantly more appropriate emotional words compared to the LP group [$F(1, 29) = 4.56, p = 0.041$] (see Figure 6).

For further analysis, I submitted the emotional lexicons to a log-liner model to test if the HP group used a cognitive tradeoff between complexity and appropriateness of emotional words, similarly to the tradeoff they made between fluency and complexity of words. Once again, contrary to my hypothesis, the HP group ($\beta = -1.337$) and the LP group ($\beta = -1.350$) had virtually no difference in the slope of their regression lines. This finding suggests that the emotional lexicon of the two groups does not deviate in complexity.

Figure 6: The "appropriateness" of the emotional words found in each fictional story. Bars reflect 95% confidence intervals.

2.2.4.2 Peer Ratings

To validate the computational methodology used in the analysis of the content, the stories were presented for peer-evaluation. For this task, 370 undergraduate students participated in the ratings. After quality control, where participant's responses for a story were removed if they spent less than 20 seconds (of a 2 minute story) on the webpage where the audio file was being played, each story was rated by an average of 21 participants.

HP individuals' stories were not rated as differing in "emotion", "entertainment", or "quality". Nor were the stories rated as having an inappropriate emotional valence, defined as the target emotion rating taken as a function of the sum of the five other emotional ratings for each story. However, psychopathy scores were negatively correlated with the average "truthfulness" rating ($r = -.37, p = .041$); this was most evident in the rating of the stories that were meant to depict fear ($r = -.39, p = .031$). Conversely, behavioural inhibition scores were found to have a moderate positive correlation with the truthfulness ratings of peers ($r = .50, p = .005$).

2.3 Discussion

2.3.1 Disfluencies

Study 1 was intended to explore the relationship between psychopathy scores and language production, as well as the relationship between language production and disfluencies. Because this was an exploratory study, with no corrections made for the number of significance tests (e.g., no Bonferroni correction applied), the likelihood of inadvertently finding a significant relationship where one does not actually exist is increased. Therefore, the results of Study 1 are meant to be taken as a guide for future

research and not as a definitive statement describing phenomenon as they are. With this in mind, I will try to draw some general conclusions.

Of particular interest was the relationship between disfluencies, working memory, and linguistic markers of complexity. Based on Study 1 results, it appears that verbalized disfluencies “um”, “uh”, and “so”, as well as silent micro- and macro-disfluencies (200 ms to 500 ms, and >500 ms, respectively) have divergent relationships. It follows that each disfluency may possess a unique relationship with cognitive processes.

I found that working memory had a strong relationship with verbalized disfluencies, consistent with previous research (Eichorn, Marton, Schwartz, Melara, & Pirutinsky, 2016). However, once disfluencies were examined individually, no significant relationship between individual disfluencies and working memory was found.

Beyond that, I explored whether there was a relationship between disfluencies and words that immediately follow. Two methodologies were used for this analysis, linear regression modeling, and ordinal ranking. Modeling revealed that words that follow disfluencies conform much better to Zipf’s law than the whole corpus. This suggests that the words that follow disfluencies are relatively less frequent, and thereby may be more difficult to retrieve (Hartsuiker & Notebaert, 2009; Kircher, Brammer, Levelt, Bartels, & McGuire, 2004). Furthermore, the distribution of words following a disfluency closely resembles distributions found in written language (Edwards & Collins, 2011). No significant differentiation between types of disfluencies was found. Contrary to this finding, a median comparison of the frequency ranks of the word sets that followed each disfluency had large variations, with “so” and “um” having a comparable frequency rank. In contrast, the set related to “uh” had a much lower frequency ranking, suggesting that

words following “uh” are less frequent words. These findings suggest that disfluencies, in general, are related to lexical access and word retrieval problems; while the disfluency of “uh” is most closely related to difficulties in production of rare words relative to other disfluencies.

Silent disfluencies were found to have no significant relationship with working memory. For macro-pauses, the most notable relationship was a negative correlation with the “so” disfluency; for micro-pauses the most notable relationship was a positive correlation with the number of words produced.

I interpret this pattern of results to mean that disfluencies are associated with unique, but interconnected, aspects of speech production. Specifically, the disfluency of “so” may be related to message forecasting. The macro-pause may serve a function related to conceptual planning. The disfluencies of “um” and “uh” appear related to lexical access but in divergent ways, where “um” is more dependent on working memory resources than the “uh” disfluency. Finally, micro-pauses appear most closely associated with word production and may be related to difficulties in the form encoding or articulation process.

2.3.2 Psychopathy

Overall, the results of Study 1 are consistent with the hypothesis that individuals high in psychopathy differ in their use of language compared to individuals low in psychopathy. Specifically, significant cognitive load is associated with extemporaneously generating a spoken fictional story for individuals high in psychopathy. Psychopathic traits predict longer duration of individual speech pauses and subsequently a longer total duration of pauses over the entire story. Cognitive load appears to be associated with

extemporaneously generating a spoken fictional story with emotional content for individuals with high psychopathy (HP) scores. This can be seen by the observation that there is no difference in fluency between HP and LP groups while producing content that is assumed to be a recollection from memory. A recollection is understood to be easier to process than a construction of a fictional story, especially if the fictional story requires the addition of emotional content. Fluency of recalled and fictional stories differed significantly for HP individuals while not significantly affecting the LP individuals, when measured by disfluencies and polysyllabic words produced. However, my results also suggest a finding counter to my hypothesis: HP individuals choose to maintain a more diverse and complex lexicon at the expense of verbal fluency when subjected to the higher cognitive load of producing fictional, compared to recall, stories.

Overall, these results replicate and extend the findings of Hancock et al. (2013) that HP individuals are less fluent, but also suggests that this may be due to a communication strategy employed by HP individuals. I propose that this effect on language production corresponds to the abnormal processing of semantic and affective language information in HP individuals observed in previous work on language perception (e.g., Kiehl, Hare, McDonald, & Brink, 1999; Mackenzie & Logan, 2014).

Future research must consider an important distinction made by Newman and Baskin-Sommers (2012) between two types of poor self-regulation: weak executive control and early selection. Weak executive selection is typical of individuals with Attention Deficit Hyperactivity Disorders (ADHD), in which poor inhibitory control is due to bottom up stimuli interfering with executive control. This type of poor behavioural inhibition causes difficulties in maintaining goal-directed behaviours. Interestingly,

individuals with ADHD have significantly more speech disfluencies, specifically correction disfluencies (Engelhardt, Corley, Nigg, & Ferreira, 2010). Correction disfluencies, also referred to as false start disfluencies, are a break in fluent speech to correct a part of the previously verbalized sentence. Alternatively, Newman and Baskin-Sommers (2012) suggest that the poor behavioural inhibition that is common to individuals high in psychopathy traits is a type of early selection bottleneck. Unlike poor inhibitory control due to bottom-up effects, psychopathic individuals become fixated on a goal, typically some form of apparently rewarding behaviour. This early selective attention creates a cognitive block for processing new information, such as the change in the attractiveness of a reward or the potential for punishment.

The finding of a positive relationship between BIS scores and fluent speech is in line with previous research (Hamilton et al., 2015; Newman & Baskin-Sommers, 2012) that suggests cognitive processing deficits associated with psychopathy are only exhibited under conditions that are unrelated to goal-directed behaviour. According to this view, individuals with high psychopathy scores and low behavioural inhibition would exhibit significantly greater speech production deficits than individuals with high psychopathy scores but individuals with high behavioural inhibition would be able to temporarily overcome the cognitive deficits. This distinction between individuals with high psychopathy scores and low behavioural inhibition compared to individuals who are high in psychopathy but have normal behavioural inhibition may be the distinguishing feature between primary and secondary psychopathy (Newman et al., 2005).

Newman and colleagues found that individuals who are classified as primary psychopaths have low BIS scores and secondary psychopaths have higher than average

behavioural approach scale scores. If it is true that speech disfluencies are the result of specific cognitive deficits (Clark & Fox Tree, 2002; Corley & Stewart, 2008; Fraundorf & Watson, 2014; Hartsuiker & Notebaert, 2009) future research could explore the different ratios of speech disfluencies (e.g., silent, “um”, “uh” etc.) to differentiate between individuals with poor behavioural inhibition and early attention bottlenecks (primary psychopathy), poor behavioural inhibition and weak executive selection (ADHD), and individuals with high BAS (secondary psychopathy).

Study 1 was limited by its exploratory nature and small sample size. These results require replication to confirm and expand on the findings. Furthermore, this research is limited by the strict exclusion of some types of disfluencies and a lack of “motivation” condition. For example, corrections and parenthetical remarks were excluded from our analysis and all participants were tested under stimulated emotion conditions.

3 Chapter: **Study 2**

Study 2 was motivated by the desire to validate the methods and replicate the results (Sokolov & Logan, 2016, 2017a, 2017b; Sokolov, Logan, & Whalen, 2017) of the exploratory study. In the exploratory study, speech produced by participants from a sample of university students was analyzed. Results from silent and verbalized speech disfluencies showed a group difference between individuals high in psychopathy scores (HP), and those who were low in psychopathy scores (LP). The high psychopathy group produced a significantly greater number of silent speech and verbalized disfluencies, with a specific preference for the “uh” disfluency. The results also showed a significant decrease in the fluency for the HP group when their cognitive load was increased, while the LP group did not experience such a drop. However, contrary to the exploratory study’s hypothesis, the HP group did not show a significant difference in their lexicon, compared to the LP group. Furthermore, during the production of “fearful” stories, the HP group produced significantly more appropriate emotional tokens compared to the LP group. Finally, a peer-evaluation of the stories did not reveal a difference in the emotionality of the stories produced by the LP and HP groups. However, the stories produced by the HP group were generally identified as less “truthful”; this was most true in the fearful story condition.

Although the methodology in Study 2 remained largely the same as that used in Study 1, conditions under which the verbal data were collected differed. In Study 1 participants produced speech samples in a sound isolated booth. A gradient of difficulty existed as part of this task, in which recollecting stories from memory was relatively easy and producing fictional stories was more challenging. Furthermore, there was an

expectation for the participants to interpret an emotional set of stimuli and produce stories corresponding emotional valence. Alternatively, Study 2 used interview data where it was expected that the answers to questions were predominantly truthful and the amount of time participants spent speaking at any given point was not constrained to the 4 minutes associated with each story in Study 1. Furthermore, there is no expectation of the participants producing emotional content in Study 2. In sum, the difficulty of the task that participants in Study 2 faced was arguably much less than the task used in Study 1. Finally, the face-to-face interaction in Study 2 increased the motivation to produce “better” speech than the isolated conditions of Study 1. Motivation is believed to be an important factor predicting the performance of individuals high in psychopathy traits (see section 2.3 for more information). Because of this, I hypothesized that that contrary to Study 1, language deficits would not be related to psychopathy scores or show a smaller effect than in Study 1, but there would be an observed difference in the number of emotional words produced, with individuals with higher psychopathy scores producing a larger number of emotional words.

3.1.1 Participants

Transcripts used in this study were derived from interviews of individuals recruited in a previous study by Flight (2004). Flight’s participants were sixty adolescent males who ranged from 16 to 20 years old ($M= 17$, $SD=0.9$) when interviewed (see Appendix C for descriptive statistics). These individuals were incarcerated at one of three institutions in Ontario: Brookside Youth Centre, Bluewater Youth Centre, and the Ottawa-Carleton Detention Centre. From this original group of 60 participants, a subset

of 31 was selected for inclusion in the present study based on the audio quality of the recordings.

3.1.2 Materials

The data in the present study were derived from 60-90 minute semi-structured interviews that were part of an evaluation for psychopathy using the Psychopathy Checklist: Youth Version (PCL:YV) (Forth, Kosson, & Hare, 2003; Neumann, Kosson, Forth, & Hare, 2006).

3.1.3 Analysis

Speech data from 31 participants was transcribed verbatim by a team of volunteers. For each interview a count of filled disfluencies “um” and “uh” was taken. Furthermore, the number of words produced, and the number of polysyllabic words (3 syllables or more) produced was also determined. For each word, a rating of emotionality, frequency and rank was assigned using custom Visual Basic scripts. The emotional valence of words was obtained from the NRC Emotion Lexicon (National Research Council Canada, 2011). Frequency and rank values for all the words were assigned according to the Frequency Words list for 2016 OpenSubtitles dataset (David, 2017).

3.2 Results

3.2.1 Fluency

A negative relationship was observed between psychopathy scores and the number of verbalized disfluencies produced ($r_s = -.45$, $p = .019$), with the strength of the relationship increasing when disfluencies were counted as a function of all words produced ($r_s = -.52$, $p = .006$). If taken individually, the negative relationship between

psychopathy scores and the disfluency “um” as a function of words produced was significant ($r_s = -.39, p = .046$). Furthermore, the negative relationship between psychopathy scores and “uh” also maintained its significance ($r_s = -.45, p = .020$). No relationship was observed between psychopathy and the number of words produced. Overall, this pattern of results for disfluencies varying as a function of psychopathy was counter to the hypothesis.

Findings from analysis of the complexity of the words used by the HP and the LP groups were also contrary to my hypothesized results. Firstly, it was observed that the polysyllabic words as a function of all words produced was negatively correlated with psychopathy scores ($r_s = -.42, p = .029$). Furthermore, when the rank and frequency of the words were subjected to a log-linear model it was revealed that the LP group had a much smaller deviation of $\beta = -1.338$ from the ideal of -1, compared to the HP group with a regression slope of $\beta = -1.432$ (see Figure 7).

Figure 7: Log-linear model of the frequency and rank of all the words produced by HP and LP individuals during interviews.

3.2.2 Emotional lexicon

Overall, a significant positive correlation was observed between the total number of emotional tokens produced and psychopathy scores ($r_s=.43, p=.026$), this relationship remained the same when the emotional tokens were taken as a factor of all words produced ($r_s=.43, p=.026$). Furthermore, a significant positive correlation was observed for the specific categories of anger ($r_s=.49, p=.009$), disgust ($r_s=.38, p=.048$), and fear ($r_s=.42, p=.030$). Overall, words with a negative emotional valence were positively correlated with psychopathy scores ($r_s=.43, p=.027$). An incidental finding showed a significant positive correlation between emotional words produced, as a function of all words produced, and psychopathy scores for Facet 1, interpersonal manipulation, ($r_s=.46,$

$p = .015$) and Facet 4, antisocial behaviors, ($r_s = .40$, $p = .040$). When the emotional lexicons for the HP and the LP groups were subjected to the log-linear model, no difference was observed, with LP group's regression slope being $\beta = -1.276$ and the HP group's slope being $\beta = -1.275$ (see Figure 8).

Figure 8: Log-linear model of all the emotional words produced by the HP and LP group during interviews.

3.3 Conclusion

The purpose of Study 2 was to validate some of the methodology and results from Study 1. An additional goal of Study 2 was to determine if the results found in Study 1 would be replicated with an incarcerated population under very different conditions of language production. I hypothesized that because of the reduced difficulty of the task, and increased motivation for using language in a more goal-oriented manner directed at

impression management, psychopathy scores would not be related to or show a smaller relationship with verbal fluency, but they would be related to the emotionality of the speech content.

Results show mixed support for the hypothesis. High psychopathy scores were correlated with the production of significantly fewer verbalized disfluencies. However, high psychopathy scores were also correlated with significantly fewer polysyllabic words and the total lexicon of the HP group appears to be much more simple than the lexicon of the LP group. Regarding emotional lexicons, the results generally support the hypothesis that HP individuals would produce more emotional words during the interviews. It should be noted that unlike Study 1, Study 2 did not have a peer-rating component which would allow for the rating of subjective factors such as the paralinguistic expression of emotions.

Overall, Study 2 suggests that individuals higher in psychopathy scores are possibly using their language in a goal-oriented way during the interviews. It appears that by using more emotional content and producing fewer disfluencies, psychopathic individuals are engaging in manipulation and impression management. However, it also appears that to balance the increased cognitive load of adding extra emotional content and retaining fluency, this group was forced to reduce the overall complexity of their message.

4 Chapter: **Discussion**

4.1 **Disfluencies**

A major goal of the present project was to explore the nature of verbal disfluencies. A total of 476 minutes of semi-spontaneous speech was analyzed from 34 participants. Of particular interest was the relationship between disfluencies, working memory, and linguistic markers of complexity. Based on the evidence collected, verbalized “um”, “uh”, and “so”, as well as silent micro- and macro- disfluencies (200 ms to 500 ms, and >500 ms, respectively), have divergent relationships such that each disfluency may possess a unique relationship with cognitive processes.

I found that working memory had a strong relationship with verbalized disfluencies, consistent with previous research (Eichorn et al., 2016). However, once disfluencies were examined individually, only the “um” disfluency had a significant relationship with working memory.

Beyond that, I explored whether there was a relationship between disfluencies and words that immediately follow. Two methodologies were used for this analysis, linear regression modeling, and ordinal ranking. Modeling revealed that words that follow disfluencies conform much better to Zipf’s law than the whole corpus. This suggests that the words that follow disfluencies are relatively less frequent, and thereby more difficult to retrieve (Hartsuiker & Notebaert, 2009; Kircher et al., 2004). Furthermore, the distribution of words following a disfluency closely resembles distributions found in written language (Edwards & Collins, 2011). No significant differentiation between types of disfluencies were observed in these analyses. In contrast, a median comparison of the frequency ranks of the word sets that followed each disfluency had large variations as a

function of different types of disfluencies, with “so” and “um” having a comparable frequency rank, whereas “uh” had a much lower frequency ranking. This suggests that words which follow “uh” tend to be less frequent words. These findings suggest that disfluencies, in general, are related to lexical access and word retrieval problems; while the “uh” disfluency is most closely related to difficulties in production of rare words relative to other disfluencies.

Silent disfluencies were found to have no significant relationship with working memory. For macro-pauses, the most notable relationship was a negative correlation with the “so” disfluency; for micro-pauses the most notable relationship was a positive correlation with the number of words produced.

I interpret the pattern of these results to mean that disfluencies are associated with unique, but interconnected, aspects of speech production. Specifically, the “so” disfluency may be related to message forecasting. The macro-pause may serve a function related to conceptual planning. The “um” and “uh” disfluencies appear related to lexical access but in divergent ways, where “um” is more dependent on working memory resources than the “uh” disfluency. Finally, micro-pauses appear most closely associated with word production and may be related to difficulties in the form encoding or articulation process.

The present research is limited by its exploratory nature. These results require replication to confirm and expand on my findings. Furthermore, this research is limited by the strict exclusion of some types of disfluencies. For example, corrections and parenthetical remarks were excluded from my analysis. One other potential limitation in the present research is the indeterminate nature of disfluencies. Although, it is relatively

uncontroversial that disfluencies result from inadequate cognitive resources being available to meet the demand (Bortfeld, Leon, Bloom, Schober, & Brennan, 2001), some researchers argue that verbalized disfluencies are culturally bound words (Clark & Fox Tree, 2002). The first part of Study 1 attempted to disambiguate the relationship between different types of disfluencies. Based on the results, it appears that while there is some overlap between disfluencies, especially “um” and “uh”, overall, they have divergent relationships with other linguistic factors, such as the number of polysyllabic words produced, and speech rate. If these findings are replicated, it would be reasonable to conclude that while there are culturally bound variations and individual differences within the phenomenon of disfluencies, as a whole the phenomenon of producing different types of disfluencies is an artifact of a struggling human cognitive system.

Another culturally bound phenomenon that may have affected the current study is the variations in prosody across cultures. However, it is unlikely to have had a significant impact on the measurement of fluency, because the shortest interruption in fluent speech that was analyzed was set at 200 ms. This duration is understood to exceed normal variation in the rhythm of speech across cultures.

In sum, I analyzed the relationship between disfluencies, working memory, and linguistic complexity markers in semi-spontaneous speech. Strong evidence was found that verbalized disfluencies of “um”, “uh”, and “so”, as well as micro- and macro-pauses, have divergent relationships. Based on these results I propose that specific disfluencies have unique relationships with the language production system, and that only some are associated with working memory for fluent speech production.

4.2 Psychopathy and Language Production

Individuals high in psychopathy personality traits have aberrant language and emotion perception abilities. Psychopathic individuals know “all the right words” to describe an emotion, but do so in a way that does not paralinguistically convey the emotion appropriately through the use of prosodic information. This interpretation suggests that the paralinguistic aspects of language production (i.e. the form) are inherently connected with emotion processing whereas the production of the language itself (i.e. the content) is related to the ToM processes.

Support for this hypothesis is provided by findings from Study 1 and Study 2 in which no significant differences were observed in the emotional content of the speech samples provided by HP and LP participants. However, in Study 1, where peers rated the subjective quality of the stories, the stories of the HP group were overall perceived as less truthful, especially the stories that were supposed to represent “fear”.

Primary psychopaths are characterized by high psychopathy scores, low anxiety, and poor behavioural inhibition (Newman et al., 2005). Poor behavioural inhibition in primary psychopaths is due to an early attention bottleneck which is responsible for suppression of information that is not related to goal-oriented behaviour (Newman & Baskin-Sommers, 2012). In sum, this suggests that language deficits of primary psychopaths would only present themselves if the context of their activity is outside their goal directed behaviour.

Supporting the above hypothesis are the divergent results from Study 1 and Study 2. They suggest that psychopathic individuals may engage in impression management techniques by reducing the number of verbalized disfluencies at the expense of verbal

complexity if they are in a context where impression management is important. In Study 1 where participants had no motivation for impression management, under low cognitive load, there was no significant distinction between the HP and the LP groups, except that the HP group produced a larger number of emotional tokens than the LP group. However, when under increased cognitive load, HP individuals began to produce significantly more disfluencies while maintaining linguistic complexity comparable to the LP group. Alternatively, in Study 2, where the cognitive load of the task was much lower, and the motivation for manipulation was much higher, the high psychopathy group produced more emotional tokens and significantly fewer disfluencies, but relied on a simpler lexicon compared to their low psychopathy peers. Finally, in Study 1 where HP participants were rated as less “truthful” than their LP counterparts while the emotional content remained comparable might suggest that HP individuals have difficulty with paralinguistic emotional production, while not being handicapped with regard to emotional content. This distinction is accurate it would suggest that HP individuals balance linguistic complexity, emotionality, and disfluencies as a strategy, which through the lens of the attentional bottle-neck hypothesis may be interpreted as a goal-directed strategy for manipulation.

The findings of my three studies suggest that there is a significant deviation in how psychopaths use language compared to non-psychopaths. Specifically, the deviation appears in relation to the paralinguistic factors of emotional language, while the emotional content remains similar, or more pronounced than, that of the non-psychopathic individuals. I propose that the effects seen in my research are an interaction of two factors: motivation and an emotional processing mechanism. I hypothesize that the

motivational component determines if the strategy that psychopathic individuals will use involves goal-directed language use. In contrast, use of the emotional processing mechanism is determined by the differentiation of content compared to the form of language. Since it is possible to directly evaluate this relationship, future studies should explicitly test the relationship between motivation, Theory of Mind, and language production.

Appendices

Appendix A Descriptive Statistics for Study 1

Table 2: Descriptive Statistics for Study 1

	Mean	Std. Deviation	Skew	Kurtosis
Age	21.2	7.6	8.765	15.42
Working Memory SRP	38.2	3.7	-2.360	1.22
Um	50.7	18.3	3.044	2.64
Um	4.26	4.62	4.848	5.66
Um/word	0.02	0.02	4.887	5.21
Uh	3.16	3.73	5.600	8.39
Uh/word	0.013	0.015	4.863	5.41
So	4.60	2.80	2.639	0.46
So/Word	0.018	0.009	1.754	-0.12
Words	245.4	55.6	.602	-0.37
Syllables/word	1.21	0.026	-.318	-1.47
Polysyllabic Words	17.45	4.34	-.128	-1.33
Polysyllabic Words /word	0.071	0.010	.651	-0.81
Micro Pause Number	30.58	9.20	.139	-1.56
Ave Macro Sum	33.24	12.74	.267	-0.57
Syllables per second	4.35	0.86	1.241	-0.23

Appendix B Research Stimuli for Study 1

Sadness

Anger

Happiness

Fear

Disgust

Surprise

Appendix C Descriptive Statistics for Study 2

Table 3: Descriptive Statistics for Study 2

	N	Mean	Std. Deviation	Skew	Kurtosis
Age	27	17.0	0.88	.000	-2.00
Total PCL-YV Score	27	18.0	8.4	.942	-1.18
Positive Tokens	31	99.1	46.4	4.265	5.64
Negative Tokens	31	96.9	49.7	3.031	2.18
Happy Tokens	31	56.0	31.5	3.637	3.01
Fearful Tokens	31	55.8	25.6	1.636	-0.21
Sadness Tokens	31	44.7	20.2	1.346	-0.32
Anger Tokens	31	62.5	32.8	3.803	3.05
Disgust Tokens	31	32.7	21.6	4.932	5.55
Sun of all Emotional Tokens	31	629.0	295.6	3.036	1.59
Number of Words	31	3460.1	1864.7	4.114	4.31
Uh/words	31	.0120	.0098	2.383	0.28
Um/words	31	.0068	.0095	8.168	17.89
Polysyllabic Words/words	31	.0728	.0194	.775	-0.02
All Disfluencies	31	59.9	57.4	6.929	13.65
Total Disfluencies/word	31	.0188	.0139	2.393	0.67

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