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Speaking under Stress: Effects on Language Production, Perceived Anxiety, Physiological Arousal, and Cognitive Attention

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Abstract

Communicating under stress can have many effects on our bodies and minds, as well as the way that we produce language. The current study employed a pseudorandomized group design to compare individuals' perceived anxiety, physiological arousal, physiological cognitive attention, and language production during stressful communication and non-stressful communication. Results indicated that the stressful communication protocol did not seem to affect individuals' self-reported anxiety, as there were no differences between the high stress and low stress groups. No between-group differences were found in physiological arousal; however, results demonstrated that the high stress group experienced an increase in physiological arousal while speaking. No between-group or within-group differences were found physiological high vigilant attention. Results did not indicate that gross language output was affected by stressful communication, but there was evidence that stressful communication did have an adverse impact on syntactic complexity of language. However, there may also have been a task effect, as participants in the low stress group were more prepared for the task than the high stress group. This study provides evidence that stressful communication may affect physiological arousal and syntactic complexity of language.

Speaking under Stress: Effects on Language Production, Perceived Anxiety, Physiological Arousal, and Cognitive Attention

by

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Thesis

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Introduction

Psychosocial Stress

From class presentations to job interviews, many of the important communication events in our lives can occur in a stressful environment. Speaking in front of a large audience or in front of a stranger (or a large audience full of strangers) can induce stress in many individuals, especially if the communication task carries significant meaning for that person's life. Stress is brought on when the body perceives a threat. It can manifest itself in a variety of forms, but here we focus on psychosocial stress, which, in turn, can be brought on by a variety of social threats (Kogler et al., 2015). In the case of a class presentation or job interview, psychosocial stress results from social-evaluative threat; that is, the person perceives the possibility of negative evaluation by others (Dickerson & Kemeny, 2004). This type of threat can lead to negative emotional states (e.g., anxiety), changes in physiological status, and changes in attention. In addition, experiencing stress during an attempt to communicate may negatively impact language function.

Defining Anxiety

"Anxiety" is often described as a negative emotional state caused by stress (Endler & Kocovski, 2001). This emotional state can be associated with subjective changes (i.e., changes in cognition and mood) and objective changes (i.e., changes in physiology; Jänig & McLachlan, 1992). Although anxiety can be defined as a psychophysiological state, it does have trait components as well. "Trait anxiety" is defined as the probability that a person will worry or devote substantial thought to anticipated stress on a daily basis. This characterizes the individual's overall predisposition to feel anxiety (Endler & Kocovski, 2001; Leal, Goes, da Salva, & Teixeira-Silva, 2017).

Healthy individuals can exhibit varying levels of state and trait anxiety; however, we must distinguish typical anxiety from an anxiety disorder, as we will not include individuals with clinical anxiety in this study. In order to be classified as having a disorder, a person must experience anxiety that is persistent over time and severe enough to be debilitating in daily functioning (Starcevic, 2005). A person with an anxiety disorder would have a severe predisposition towards anxiety and thus, high trait anxiety. An anxiety disorder may affect state anxiety as well, as physiological arousal in response to stress may become so severe that a person can no longer function (Starcevic, 2005).

Stress and Language Function

Typical responses to stress may not severely impair a person's ability to function, but they can have temporary effects on performance in certain tasks. The "performance" we are interested in for this study is language performance, or production. Effects of psychosocial stress on language production are frequently studied in adult second language learners. Members of this population often feel anxiety in communication situations, due to the possibility of negative evaluation from other, more proficient speakers (Horwitz, Horwitz, & Cope, 1986; Cahana-Amitay et al., 2015).

Most of the studies in this area assess *trait* anxiety in relation to language production, rather than acute psychosocial stress. In general, individuals who report more anxiety regarding use of their non-native language tend to exhibit less proficient use of that language. Trait anxiety regarding language use is often assessed by asking participants to rate how anxious they would feel in hypothetical situations. For instance, a participant may be asked to rate how anxious she would feel participating in a classroom discussion in the non-native language (Horwitz et al., 1986; Woodrow, 2006). Language production is often assessed by grades in foreign language classes (McIntyre & Gardner, 1994; Ganschow & Sparks, 1996), performance on written tasks (Gardner & McIntyre, 1993; Sheen, 2008), or oral language tasks (Steinburg & Horwitz, 1986; Philips, 1992; Woodrow, 2006; Trebits, 2016), which is our primary interest for this study. Philips (1992) found that French language learners who reported more anxiety regarding French use tended to produce fewer utterances and use simpler syntactic structures when speaking. In English language learners, Trebits (2016) found that those who reported more anxiety regarding their language output tended to commit more syntactic errors during a narrative production task. Woodrow (2006) also found that English language learners who reported more anxiety regarding English use received lower grades for fluency, language usage, and pronunciation in a standardized oral language proficiency task.

Steering away from assessing trait anxiety with hypothetical situations, Steinburg and Horwitz (1986) induced psychosocial stress, and subsequent *state* anxiety, in English language learners. They asked participants to describe ambiguous pictures and make inferences while being video- and audio-recorded. Participants in this condition reported that it made them feel anxious. They tended to make fewer inferences and use less complex, interpretive language than participants who did not perform the task under stress (Steinburg & Horwitz, 1986). This indicates that acute psychosocial stress can negatively impact subtle aspects of language production. Although the literature indicates that trait anxiety and psychosocial stress may negatively impact language production in language learners, the nature of this interaction in native language speakers remains to be seen.

Stress and Autonomic Nervous System Activity

Inducing psychosocial stress, rather than asking participants to rate anxiety in hypothetical situations, can provide a clearer view of how stress affects language production. If this method is pursued, researchers must ensure that experimental conditions actually induce stress. Self-report measures could be used to achieve this end, but physiological measures can also be used in conjunction to observe the experience of stress more objectively.

We can use physiological measures to assess a psychosocial stress response because the body undergoes physiological changes in the presence of a threat. When a threat is perceived, the sympathetic nervous system coordinates the “fight-or-flight” response to protect the body (Jänig & McLachlan, 1992). This results in activity such as increased cortisol (stress hormone) secretion, elevated heart rate, and increased activity in the sweat glands (Dawson, Schell, & Filion, 2000; Gordan, Gwathmey, & Xie, 2015; Adam et al., 2017).

Cortisol secretion and heart rate have been shown to increase in native language speakers in certain communication situations. Public speaking, especially, appears to elicit increased cortisol secretion and elevated heart rate (Croft, Gonsalvez, Gander, Lechem, & Barry, 2004; Takahashi et al., 2005; Lam, Dickerson, Zoccola, & Zaldivar, 2009; Kothgassner et al., 2016). However, cortisol and heart rate are limited as physiological measures of state anxiety and psychosocial stress. Cortisol levels fluctuate throughout the day, requiring tight experimental controls to ensure that differences are not due to regular fluctuations (Ross, Murphy, Adam, Chen, & Miller, 2014; Adam et al., 2017). They also respond to relatively specific threats, which requires even further experimental controls to ensure that conditions are ideal for eliciting a response (Dickerson & Kemeny, 2004). Moreover, the heart is innervated by the sympathetic nervous system *and* the parasympathetic nervous system, which is responsible for bringing the body back to rest after sympathetic activation (Gordan et al., 2015). Thus, heart rate data must then be interpreted with caution, as they may not be solely indicative of stress-related physiological arousal.

Due to the limitations of cortisol and heart rate as physiological measures of stress, we will employ a measure of electrodermal activity in this study. Electrodermal activity is a broad term used to refer to changes in electrical activity on the surface of the skin. These changes are generated by the sympathetic nervous system (Dawson et al., 2000; Kriebig, 2010). When threats are perceived, the sympathetic nervous system increases activity in the sweat glands underneath the skin; sweat then fills the sweat ducts, and the path to the surface of the skin becomes more conductive to electricity (Dawson et al., 2000). Skin conductance level, a subtype of electrodermal activity, refers to changes in current flow on the surface of the skin as a result of sympathetic activity (Dawson et al., 2000). This can be assessed by placing electrodes on the skin, passing a small current through them at a constant voltage, and measuring changes in current flow over time (Dawson et al., 2000).

Skin conductance level responds to social-evaluative threat in native language speakers. When participants are in the midst of a public speaking task, skin conductance level is often much higher than baseline (Croft et al., 2004; Parente, Garcia-Leal, Del-Ben, Guimarães, & Graeff, 2005; Hofmann et al., 2006; Westenberg et al., 2009). It increases even more drastically in such tasks if participants report higher levels of trait anxiety (Hofmann et al., 2006).The audience does not have to be large to provoke changes in skin conductance level, either. Increases have been observed in participants who spoke before only two audience members (Hoffman et al., 2006). Skin conductance level can also increase during anticipation of a public speaking event (Parente et al., 2005; Hofmann et al., 2006; Westenberg et al., 2009) and may fall to below-baseline levels after public speaking has ceased (Croft et al., 2004). Furthermore, increases in skin conductance level appear to be well-correlated with increases in self-reported anxiety before and during a public speaking task (Parente et al., 2005; Westenberg et al., 2009).

Skin conductance level is closely linked to sympathetic nervous system activity; does not have regular, daily fluctuations; responds to stressful communication situations; and correlates with self-report measures of anxiety (Dawson et al., 2000; Croft et al., 2004; Parente et al., 2005; Westenberg et al., 2009). Thus, it is an ideal measure for assessing physiological arousal during a stressful communication task. Because of its link to the sympathetic nervous system, we can also use skin conductance level to assess if our "stressful" communication task does, in fact, induce stress.

Stress and Attention

Attention is another aspect of functioning that can be affected by psychosocial stress. Stress-related impairments in attention have frequently been measured behaviorally, by assessing performance on attention-demanding tasks. These tasks often ask participants to attend to stimuli and make decisions based on the characteristics of a stimulus (Plessow, Schade, Kirschbaum, & Fischer, 2012; Sänger, Bechtold, Schoofs, Blaszkewicz, & Wascher, 2014; Olver, Pinney, Maruff, & Norman, 2015). For instance, the task instructions may be to press a button on a keyboard whenever a red playing card appears on a computer screen (Olver et al., 2015). In general, psychosocial stress leads to more errors and slower response times on such tasks (Plessow et al., 2012; Sänger, et al., 2014; Olver, et al., 2015).

Behavioral measures of attention are helpful in quantifying the negative effects of psychosocial stress on performance. However, if we want to observe rapid changes in attention, especially over a short period of time, behavioral measures may not be as useful as physiological measures. Physiological measures of attention, such as electroencephalography (EEG), have good temporal resolution and, thus, can shed light on small fluctuations in attention during short time periods (Robertson & O'Connell, 2010).

EEG provides information about electrical activity in large portions of the brain (Biasiucci, Franceschiello, & Murray, 2019). In the past, researchers have decomposed raw EEG data into sine waves and calculated the frequency of these waves. These frequencies have been categorized into delta, theta, alpha, beta, and gamma frequency bands (Biasiucci et al., 2019; Tivadar & Murray, 2019). These frequency bands have historically been associated with certain cognitive states: delta and theta (the lower frequencies) with sleep or drowsiness; alpha (the middle frequency) with wakeful relaxation; and beta (the higher frequency) with activity and alertness (Niedermeyer, 2005). However, other methods of classifying raw EEG data are being implemented in research today.

EEG activity, though classified in different ways across studies, appears to be related to cognitive attention. Increasingly difficult and cognitively-demanding tasks tend to elicit more "vigilant" attention, as measured by certain frequency bands in EEG (Berka et al., 2004; Stephens, Galloway, & Berka, 2007; Johnson et al., 2011). Vigilant attention refers to the act of actively attending to the current task (Robertson & O'Connell, 2010). During sustained attention tasks, EEG activity increases in the alpha frequency band and can be used to predict errors on sustained attention tasks (O'Connell et al., 2009; Martel, Dähne, & Blankertz, 2014). When stress was introduced to an attention-demanding flanker task (attending to a central stimulus while ignoring distractor stimuli), EEG activity tended to increase early in each trial and decrease later in each trial (Shackman, Maxwell, McMenamin, Greischar, & Davidson, 2011). This EEG activity was predictive of errors committed on the task in stressful conditions (Shackman et al., 2011).

EEG activity is related to subjective ratings of attention, as well. Putman and colleagues (2014) found that changes in the ratio of theta and beta EEG frequency bands were predictive of stress-related declines in perceived levels of attentional control. This ratio also moderated the effect of stress on attentional control (Putman et al., 2014). Though studies have investigated the relationship between stress, attention, and cognitive performance, there is a lack of information regarding this relationship in a linguistic task.

Present Study

This study aims to investigate the effects of stressful communication on language output, as well as perceived anxiety, physiological arousal (skin conductance level), and physiological vigilant attention (EEG). To reduce the risk of confounding variables, we examine these processes in healthy young adults who do not have a history of anxiety disorders or any other neurological, psychological, or speech/language disorders. Because bilingual speakers can report higher trait anxiety and skin conductance levels when speaking their non-dominant language (Sevinç, 2018), we recruited monolingual English speakers to further reduce the possibility of confounds.

We assigned one group of participants, the high stress group, to engage in stressful communication, where social-evaluative threat is present. Another group of participants, the low stress group, engaged in relatively non-stressful communication, where social-evaluative threat appears unlikely. By doing so, we may address the following questions: 1) does the high stress group report greater anxiety following their task than the low stress group? 2) does the high stress group exhibit higher skin conductance levels during their task than the low stress group? 3) does the high stress group spend more time in a state of high vigilant attention during the task than the low stress group? 4) does the high stress group produce less complex language than that of the low stress group?

Regarding question 1, we know that anxiety can be brought on by social-evaluative threat (Endler & Kocovski, 2001), and participants have been shown to report higher levels of anxiety following public speaking tasks (Parente et al., 2005; Westenberg et al., 2009). Therefore, we hypothesized that the high stress group would report higher levels of anxiety than the low stress group, following their respective experimental tasks.

Regarding question 2, we know that skin conductance level tends to increase during public speaking tasks (Croft et al., 2004; Parente et al., 2005; Westenberg et al., 2009) or a speaking task in front of experimenters (Hofmann et al., 2005). Therefore, we hypothesized that skin conductance level will increase during a speaking task, regardless of experimental condition. However, we expect that the high stress group will evidence a significantly greater increase than the low stress group from baseline to the task periods. This is due to the fact that the stressful task will contain an element of social evaluation, which can be stress-inducing (Endler & Kocovski, 2001), while the non-stressful task will not.

Regarding question 3, we know that electrophysiological signals from EEG in certain frequency can increase or become active in response to psychosocial stress, as well as cognitively-demanding tasks. Therefore, we expect that attempting to produce language will elicit high vigilant attention, regardless of experimental condition. However, we expect that the high stress group will spend significantly more time in a state of high vigilant attention than the low stress group because of the social-evaluative threat.

Regarding question 4, we know that perceived anxiety regarding language use and the presence of evaluation can negatively impact the complexity of language production (Steinburg & Horwitz, 1986; Philips, 1992; Woodrow, 2006; Trebits, 2016). Therefore, we expect that when participants speak in front of an evaluator, their language production will be less complex than that of participants who speak without evaluation.

Method

Participants

Participants were 16 young healthy adults, between the ages of 18 and 33 (4 males). They were recruited from Syracuse University by email, flyers, and word-of-mouth. Upon expressing interest in participating in the study, participants were sent a survey by email to determine their eligibility for the study and to collect demographic information. Participants reported if they had a history of neurological, psychological, or speech/language impairments, and if they had a history of anxiety disorders. Any participant who reported a history for any of these disorders was excluded from the study. In addition, participants reported their primary language (i.e., the language that they speak the majority of the time at home and at school/work). Any participant who reported a primary language other than English was excluded from the study. One participant reported bilingual status, being a native speaker of both English and Spanish; however, she reported that she spoke English almost exclusively at school and was therefore included in this study.

These exclusionary criteria ensured that any differences in complexity of language production or stress responses were due to experimental manipulation, rather than proficiency in spoken English or prior psychological disturbances. Demographic data regarding participants' age, gender, and handedness was also collected (see Table 1).

Participant	Age	Gender	Handedness
1001	19	Female	Right
1003	19	Male	Right
1007	21	Female	Right
1009	20	Female	Right
1011	22	Female	Right
1013	27	Male	Right
1015	19	Female	Right
1021	33	Female	Right
2002	21	Female	Right
2004	20	Female	Right
2008	21	Female	Right
2010	22	Female	Right
2012	26	Female	Right
2014	18	Female	Right
2022	25	Male	Right
2024	28	Male	Right

Table 1. Demographic data for all participants.

Experimental Procedure

Participants who met the inclusion criteria for the study completed the experiment at the Aphasia Lab at Syracuse University over two visits. During the first visit, participants reviewed and signed a consent form, which informed them of the current study, the physiological measures that would be taken, and any potential risks or benefits of participating in the study.

The participants were assigned to experimental groups by pseudorandomization and counterbalancing. The first participant who expressed interest in the study and met the inclusion criteria was assigned to a condition by a random number generator. An odd number was generated, so the participant was assigned to the high stress group. The next participant to meet the inclusion criteria was then assigned to the low stress group. Participants continued to be assigned to groups in this fashion, alternating between low stress and high stress based on the order in which they completed the initial survey.

Participants then completed the 3 benchmark EEG tasks to establish their individual EEG patterns. The experimental tasks were completed on a second visit to the lab. At the second visit, participants completed the Dundee Stress State Questionnaire, Short Form, pre-task questions (Matthews et al., 1999), after hearing task instructions but before completing the experimental task. Those in the high stress group then completed the modified Trier Social Stress Test, and those in the low stress group completed the control task. Both experimental tasks lasted approximately 20 minutes. EEG and skin conductance level data were collected during the baseline, planning, experimental, and recovery conditions of both tasks. After the tasks concluded, participants completed the Dundee Stress State Questionnaire, Short Form post-task questions (Matthews et al., 1999). Both administrations of the Dundee Stress State Questionnaire, Short Form contain 30 questions. After completing the post-task Dundee Stress State Questionnaire, participants were debriefed regarding the true nature and purpose of the study. See Figure 1 for a visual diagram of the procedure.

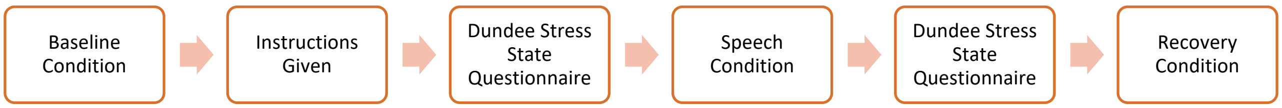

Figure 1. Diagram of procedure for all participants on day 2 of the experiment.

Study Design

The present study employed a pseudorandomized comparative group design with 2 independent variables and 4 dependent variable categories. The independent variables were experimental group (high stress or low stress) and condition (baseline, planning, speech condition, and recovery). Participants in the high stress group completed the modified Trier Social Stress Test, whereas participants in the low stress group completed a control protocol. The dependent variable categories were perceived anxiety, skin conductance level, EEG-measured vigilant attention, and complexity of language production. Each of these variables is described in detail in the following sections.

Stress Protocol. A modified version of the Trier Social Stress Test was employed in this study to induce stress via social-evaluative threat. The Trier Social Stress Test is a well-validated experimental protocol developed to induce stress in an experimental setting (Allen et al., 2017). It consists of four conditions: baseline rest, planning, stress procedure, and recovery period

(Allen, Kennedy, Cryan, Dinan, & Clarke, 2014; Allen et al., 2017). In the baseline rest period, participants sat quietly for 5 minutes while baseline physiological measures (in this study, skin conductance level and EEG activity) were collected. After the baseline period, the experimenter instructed participants to imagine that they had been given an opportunity to interview for their ideal job. Their task was to prepare a 3-minute speech that would convince committee members that they were the ideal candidate for the position. They were allotted 5 minutes to plan their speech, and pen and paper was provided to write down ideas. Before beginning planning, participants were informed that the experimenter would be taking notes and analyzing their performance during their speech and that their performance would be video-recorded for later analysis. The experimenter then left the participant alone in the testing room during this 5-minute period. Once the planning period was complete, the experimenter re-entered the room, pointed out the location of the video camera, and set up a microphone for audio-recording. During the 3-minute spontaneous portion of the speech condition, the experimenter took notes and did not provide any positive nonverbal feedback (e.g., nodding the head, smiling). After the participant concluded his or her spontaneous speaking portion, the experimenter asked questions from a predetermined list (see Appendix A; Kudielka, Hellhammer, & Kirschbaum, 2007). Once the participant completed the speaking condition, the experimenter removed the microphone and left the participant to sit in the room alone for 5 minutes, which served as the recovery period.

In comparison to the originally published version of the Trier Social Stress Test, this version was modified in two ways. First, only one experimenter was present, rather than a committee of confederates. Most researchers who employ the Trier Social Stress Test ask participants to speak in front of at least one male and one female evaluator (Campbell & Ehlert, 2012), but some studies have administered the protocol and observed physiological changes with a video camera only and no evaluator (Marsland, Manuck, Fazzari, Stewart, & Rabin, 1995; Cohen et al., 2000). Dohrmann, Hennig, and Netter (1999) employed a design with a video camera and one evaluator and observed increases in skin conductance level. However, they also promoted the idea of a “panel” of judges by showing a video of multiple confederates who were supposedly watching from an adjacent room (Rohrmann et al., 1999). For the purposes of this study, we decided to use only one evaluator in lieu of a larger virtual audience, because speaking in front of a real audience versus a virtual or imagined audience provokes greater changes in physiological arousal (Kelly, Matheson, Martinez, Merali, & Anisman, 2007).

The second modification eliminated a surprise mental arithmetic task that is typically included in the stress procedure. Because we were primarily interested in stress in the context of communication, we wanted to ensure that physiological responses were due to social-evaluative threat of communication and not the stress of a calculation task. The mental arithmetic portion of the Trier Social Stress Test does not seem to be necessary for evoking physiological responses, as versions of the task omitting the arithmetic portion have been shown to provoke increases in physiological measures of arousal (Jezova, Makastori, Duncko, Moncek, & Jazubek, 2004; Weimers, Schoofs, & Wolf, 2013).

Control Protocol. The control protocol employed in the current study was similar to a proposed “placebo version” of the Trier Social Stress Test (Het, Rohleder, Schoofs, Kirschbaum, and Wolf, 2009). In order to keep the language content similar across experimental tasks, participants in this condition were asked to speak for 3 minutes about their ideal career and explain why that career appealed to them. As in the modified Trier Social Stress Test, participants were given 5 minutes to prepare their ideas, with pen and paper, before engaging in the speech condition. In addition, participants were told that the experimenter would ask certain questions at the end of the speaking condition; these questions were provided to participants so that the possibility of inducing anxiety in this condition would be even more reduced. The experimenter left the participant alone in the testing room for the 5-minute planning period. After the planning period was over, the experimenter returned to the room and set up a microphone. The experimenter explained to participants that they would be audio-recorded for acoustic analysis of their voices. This explanation was provided in order to ensure that participants' speeches would be recorded without inducing stress. We predicted that participants would not experience stress in this case because the acoustics of their voice is not related to their performance or the content of their speech. While the participant spoke, the experimenter occasionally nodded, smiled, or offered other nonverbal signs of encouragement. Once the participant concluded his or her spontaneous speaking portion, the experimenter asked the predetermined questions (see Appendix A). After all the questions were asked, the experimenter removed the microphone and left the participant alone in the room for a 5-minute recovery period.

Perceived Anxiety Measure

To assess participants' subjective experience of the experimental protocols, we employed the Dundee Stress State Questionnaire, Short Form (Appendix B; Matthews et al., 1999), a well-researched measure that assesses the subjective experience of state anxiety, as a result of stress (Matthews, Szalma, Panganiban, Neubauer, & Warm, 2013). The Dundee Stress State Questionnaire measures three factors of stress states: task engagement (e.g., "The content of the task is interesting"), distress (e.g. "I feel…nervous"), and worry (e.g., "I am worrying about looking foolish; Matthews et al., 2013). These higher-order factors are composed of first-order factors, or scales. See Table 2 for a summary of the higher-order factors and their component scales.

Factor	**Scale**	**Example item**
Task Engagement	Energetic arousal	I feel... Vigorous
	Task Interest	The content of the task is interesting
	Success Motivation	I want to perform better than most people do
	Concentration	My mind is wandering a great deal (negative item)
Distress	Tension	I feel... Nervous
	Hedonic Tone (low)	I feel... Contented
	Confidence-Control (low)	I feel confident about my abilities
Worry	Self-Focus	I am reflecting about myself
	Self-Esteem	I am worrying about looking foolish (negative item)
	CI (task-relevant)	I have thoughts of... How much time I have left
	CI (task-irrelevant)	I have thoughts of... Personal worries

Table 2. Scales of the Dundee Stress State Questionnaire. "CI" = Cognitive Interference. From Matthews et al., 2013.

The Dundee Stress State Questionnaire assesses these 9 scales before and after participants complete an experimental task (Matthews et al., 2013), which was useful for understanding how our experimental tasks affect participants' self-reported anxiety levels.

Physiological Measures

Skin conductance level. Skin conductance level served as an objective measure of physiological arousal. The data were acquired using the Biopac MP150 system and analyzed using Acqknowledge software. Because participants were not presented with stimuli, tonic skin conductance level was collected. Tonic skin conductance refers to the background physiological activity that is not linked to any specific stimuli. Skin conductance level was continually acquired from two electrodes placed on the distal phalanges of the index and middle fingers of the participant's non-dominant hand (Boucsein et al., 2012; Dawson et al., 2000).

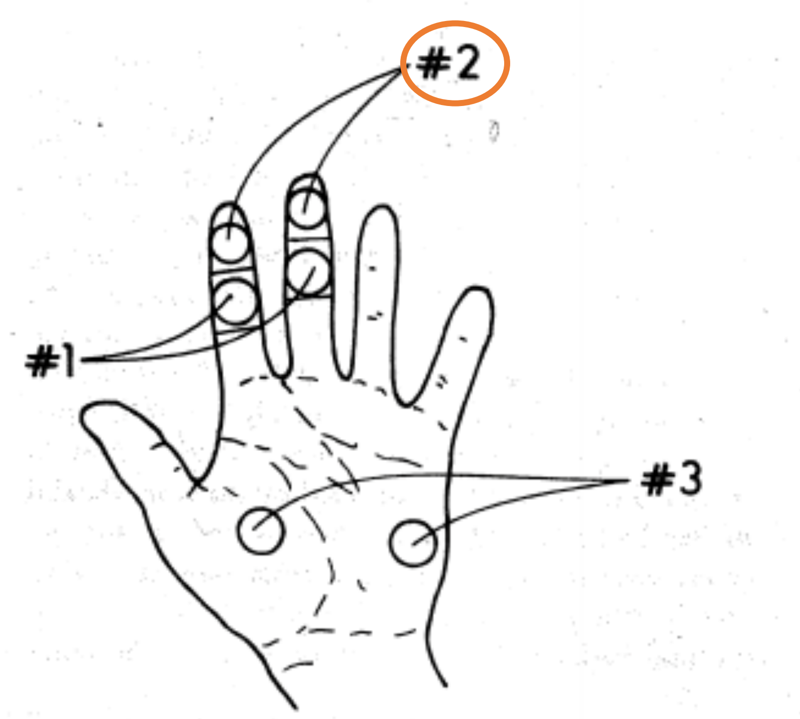

Figure 2. Electrode placement for skin conductance level. The configuration used in this study is circled in orange.

The mean tonic skin conductance level was calculated during the 4 conditions of the experiment: 5 minutes of baseline rest; 5 minutes of planning time; variable minutes of the speech condition, depending on how long the participants spoke; and 5 minutes of recovery.

Physiological Vigilant Attention Measure. Continuous EEG data were collected throughout the duration of each experimental condition (baseline, planning, speech, and recovery). These data were used to quantify physiologically-measured vigilant attention in all study participants. EEG data were collected using a B-Alert® X10 (Advanced Brain Monitoring), an electrophysiological system that uses Bluetooth wireless data transmission. The X10 system provides up to 9 channels of EEG data with a sampling rate of 256 Hz.

After completing the consent and screening process, participants were fitted with the EEG data collection equipment (X10). Electrode placement on the scalp was based on the international 10-20 EEG system, placing the Fz electrode at 30% above the nasion (see Figure 3). Reference electrodes was placed on the left and right mastoids. Participants came in on a separate day from testing to undergo three EEG benchmark tasks: a three-choice psychomotor

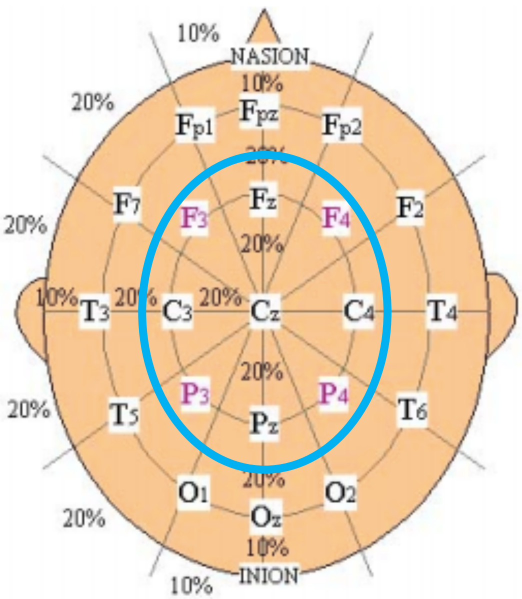

Figure 3. Diagram of EEG electrode placement. Electrodes used in this study are circled in blue.

vigilance task, an eyes-open finger-tapping task, and an eyes-closed finger-tapping task (Johnson et al., 2011). From these data, we used B-Alert Live software to create individual definition files for each participant. These definition files were used to classify EEG responses in subsequent data analysis. Following generation of a participant-specific definition file, participants completed either the modified Trier Social Stress Test or the control protocol while EEG continuously recorded data.

For this experiment, we analyzed EEG data from nine electrodes on the scalp (Frontal: F3, Fz, F4; Central: C3, Cz, C4; Posterior: P3, Poz, P4). These raw EEG data were used to classify cognitive states according to a classification algorithm developed by Berka et al. (2004) and validated by Johnson et al (2011). This algorithm allows for 4 states of activity: high vigilant attention, low vigilant attention, distraction, and sleep onset. Individual differences in EEG responses were accounted for by using performance on the benchmark tasks to create classification criteria for the 4 cognitive states. Since individual stimuli were not presented in this study, we analyzed EEG data in the 4 conditions of the experiment. The classification algorithm was applied to determine the amount of time spent in a state of high vigilant attention during each of the conditions.

Language Production Measures

Language production was quantified with two measures: mean length of communication units (measured in words) and clausal density. Mean length of communication units is a measure of gross language output, the average number of words an individual produces in each of his or her utterances. A communication unit (or C-unit) is defined as the smallest unit of spoken language that cannot be further divided without losing its meaning (Hunt, 1966; Loban, 1976). One C-unit comprises one independent clause and any dependent clauses connected by a dependent marker. An independent clause contains a subject and verb, and it can stand alone as a sentence without modification: for instance, “She [subject] ran [object]”. A dependent clause also contains a subject and verb, but it cannot stand alone as a sentence because of the presence of some dependent marker: for instance, “Because [dependent marker] she was scared”. Grammatically, the previous statement would be considered a sentence fragment. Below is an example of a person’s spoken language segmented into C-units, which are represented by slashes (Nippold, Hesketh, Duthie, & Mansfield, 2005):

> "And I like our dogs a lot / they're kind of like our children / and we train our dogs a little bit of obedience, which is fun"

The above sample is classified as 3 C-units because there are 3 independent clauses. The phrase, "which is fun" is not classified as an independent clause because it cannot stand alone as grammatical sentence.

Clausal density is a measure of syntactic complexity. It is defined as the total number of clauses (independent and dependent) divided by the total number of C-units (Westerveld & Moran, 2011). In the example below (Nippold et al., 2005), C-units are represented by slashes once more, independent clauses are bolded, and dependent clauses are underlined.

> "**And I like our dogs a lot / they're kind of like our children / and we train our dogs a little bit of obedience,** <u>which is fun</u>"

Thus, the clausal density would be calculated as 4 (total number of clauses) / 3 (total number of C-units) = 1.33. A higher clausal density is indicative of more complex language and advanced language development (Westerveld & Moran, 2011). Although these measures are frequently used to assess children's language development, they can also be used to assess the complexity of adult speech (Nippold et al., 2005; Nippold, Cramond, & Hayward-Mayhew, 2014).

Data Analysis

Normality. A Shapiro-Wilk test of normality was conducted to determine if the data in this sample were distributed normally. Results were significant for all dependent variables, indicating that the data in this sample most likely do not follow a normal distribution. Due to this result, and the small sample size (8 participants in each group), nonparametric statistical tests were used throughout data analysis.

Perceived anxiety. Participants recorded answers for the questions on both administrations of the Dundee Stress State Questionnaire, Short Form, on a scale from 0 (definitely false) to 4 (definitely true). Scores for the 3 factors (engagement, distress, and worry) measured by this questionnaire were calculated according to the formula provided by Matthews et al (2013). Thus, each participant received a pre-task and post-task score for engagement, distress, and worry. Independent samples Mann-Whitney U tests were conducted to compare engagement, distress, and worry between the high stress and low stress groups. Related-samples Wilcoxon signed rank tests were conducted to compare these 3 factors from pre-task to post-task within the high stress and low stress groups.

Skin conductance level. The first and last ten seconds of each condition of the study were deleted in order to ensure that any changes in skin conductance level were due to the experimental condition and not extraneous factors (e.g., the experimenter re-entering the room at the end of the condition). Change scores, rather than raw skin conductance level data, were used in data analysis. Change scores were calculated by subtracting the mean skin conductance level during the baseline condition from the mean skin conductance levels in the planning, speech, and recovery conditions. Change scores for skin conductance level during the spontaneous and questions portions of the speech condition were also calculated by subtracting the mean skin conductance level at baseline. An independent samples Mann-Whitney U test was conducted to compare skin conductance level change scores between the experimental groups. Independent samples Mann-Whitney U tests were also used to compare skin conductance level change scores between the two groups in the spontaneous and questions portions of the speech condition. Related-samples Friedman's two-way ANOVA tests were conducted to compare skin conductance level change scores across the 4 conditions in both groups. Separate related-samples

Wilcoxon signed rank tests were conducted to compare skin conductance level change scores across the two portions of the speech condition in both groups.

Physiological vigilant attention. The B-Alert® software used in this study employed an algorithm to calculate the probability that a participant was in each of the 4 states of vigilant attention (sleep onset, low vigilant attention, moderate vigilant attention, and high vigilant attention) for each second that data was collected. The participant's cognitive state was predicted for each second of data collection based on the highest probability calculated. We counted the number of seconds that the software predicted participants were in a state of high vigilant attention and divided that number by the total number of seconds of data collection. Any seconds in which the software could not calculate probabilities was deleted. This calculation was repeated for each of the 4 study conditions (baseline, planning, speech, and recovery), providing us with the proportion of time spent in high vigilant attention. An independent samples Mann-Whitney U test was conducted to compare the proportion of time spent in high vigilant attention between the high stress and low stress groups. Related-samples Friedman's two-way ANOVA tests were conducted to compare the proportion of time spent in high vigilant attention across the 4 conditions in both groups.

Language production. Each participant's speech was hand-transcribed using the audio recorded during the experiment. The transcription was segmented into C-units according to conventions in SALT (Systemic Analysis of Language Transcripts; Appendix C). The number of words in each C-unit was counted, excluding non-meaningful words, false starts, and repetitions (Appendix C). The total number of words was divided by the total number of C-units to calculate the mean length of C-unit for each participant. This calculation was repeated separately for each participant's spontaneous and questions portions of the speech condition. Using the same segmentation of C-units, we counted the number of clauses in each utterance (Appendix C). The total number of clauses was then divided by the total number of C-units to calculate the total clausal density. This calculation was repeated separately for each participant's spontaneous and questions portions of the speech condition. A separate coder, a graduate student in speech-language pathology, was provided with the conventions for transcription and coding the two language measures and transcribed the first 60 seconds of all participants' speeches. Inter-rater reliability was found to be 91% for segmentation of C-units, 98% for mean length of C-unit, and 94% for clausal density. Any discrepancies in segmentation, counting of words, or counting of clauses was discussed to reach 100% reliability. Independent samples Mann-Whitney U tests were conducted to compare mean length of C-unit and clausal density between the two groups. Related-samples Wilcoxon signed rank tests were conducted to compare mean length of C-unit and clausal density across the two portions of the speech condition in both groups.

Results

Perceived Anxiety

All 3 of the factors measured by the Dundee Stress State Questionnaire, Short Form had a score range from 0 to 32. The two groups did not significantly differ in reported pre-task levels of engagement (high stress: M=24.438, low stress: M=22.938; U=22.5; p=.442), distress (high stress: M=15.063, low stress: M=19.125; U=15.0; p=.505), or worry (high stress: M=9.625, low stress: M=10.938; U=12.0; p=.130). Significant between-group differences were also absent in post-task engagement (high stress: M=24.25, low stress: M=26.0; U=23.0; p=.505), distress (high stress: M=16.88, low stress: M=17; U=14.5; p=.083), or worry (high stress: M=12.5, low stress: M=7.63; U=18.75; p=.878). See Figure 4.

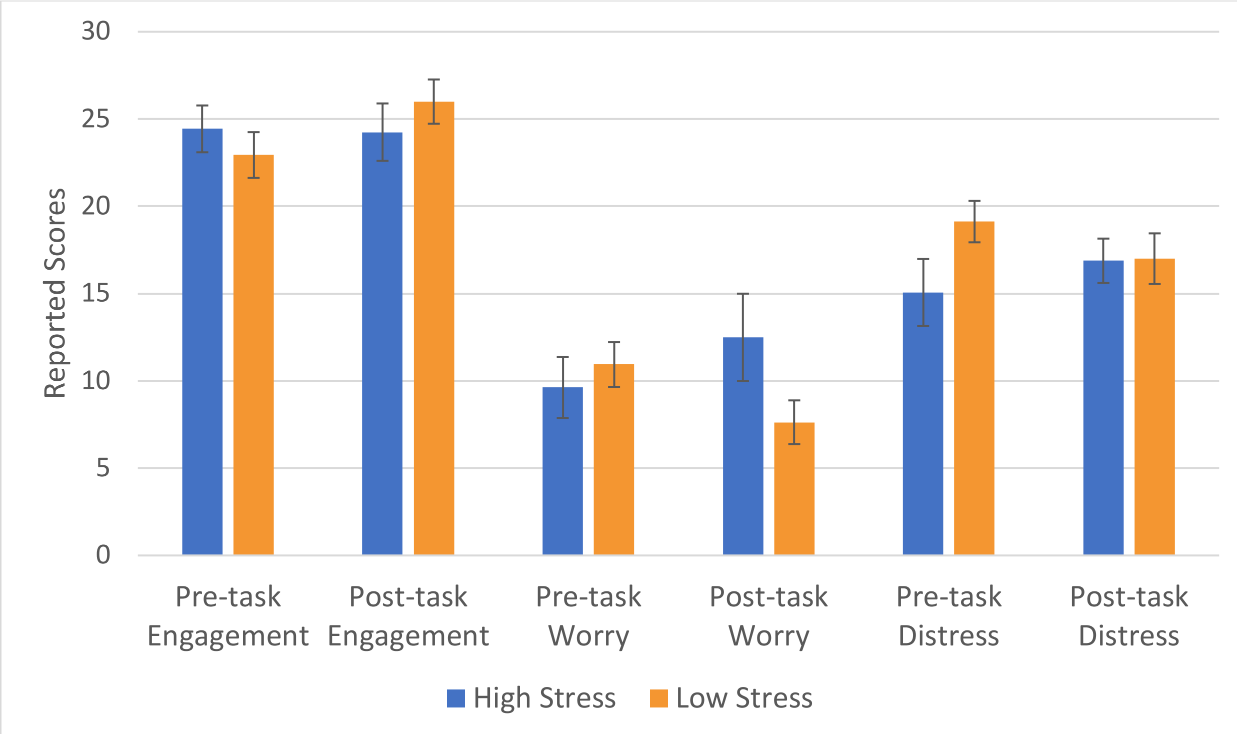

Figure 4. Differences between and within groups for reported anxiety on the Dundee Stress State Questionnaire, Short Form. Error bars represent standard error.

From pre-task to post-task, the high stress group did not report any significant changes in engagement (*W*=8.0, *p*=.893), distress (*W*=20.0, *p*=.307), or worry (*W*=26.5, *p*=.233). The low stress group followed a similar pattern, with no significant differences from pre-task to post-task administrations (engagement: *W*=24.0, *p*=.089; distress: *W*=8.0, *p*=.161; worry: *W*=4.0, *p*=.089). See Figure 4.

Skin Conductance Level

There were no significant differences in overall skin conductance level change scores between the high stress and low stress groups during the planning (high stress: M=3.4565, low stress=2.7051; *U*=16.0; *p* = .645), speech (high stress: M=6.2145, low stress=2.9345; *U*=12.0; *p* = .105), or recovery (high stress: M=2.6139, low stress: M=1.2343; *U*=15.0; *p* = .721) conditions. However, skin conductance level change scores in the high stress group were significantly higher during the speech condition than during the planning or recovery conditions

(*Q*=20.5, *p*=.008). The low stress group did not exhibit any significant differences in skin conductance level change scores across conditions (*Q*=3.25, *p*=.197). See Figure 5.

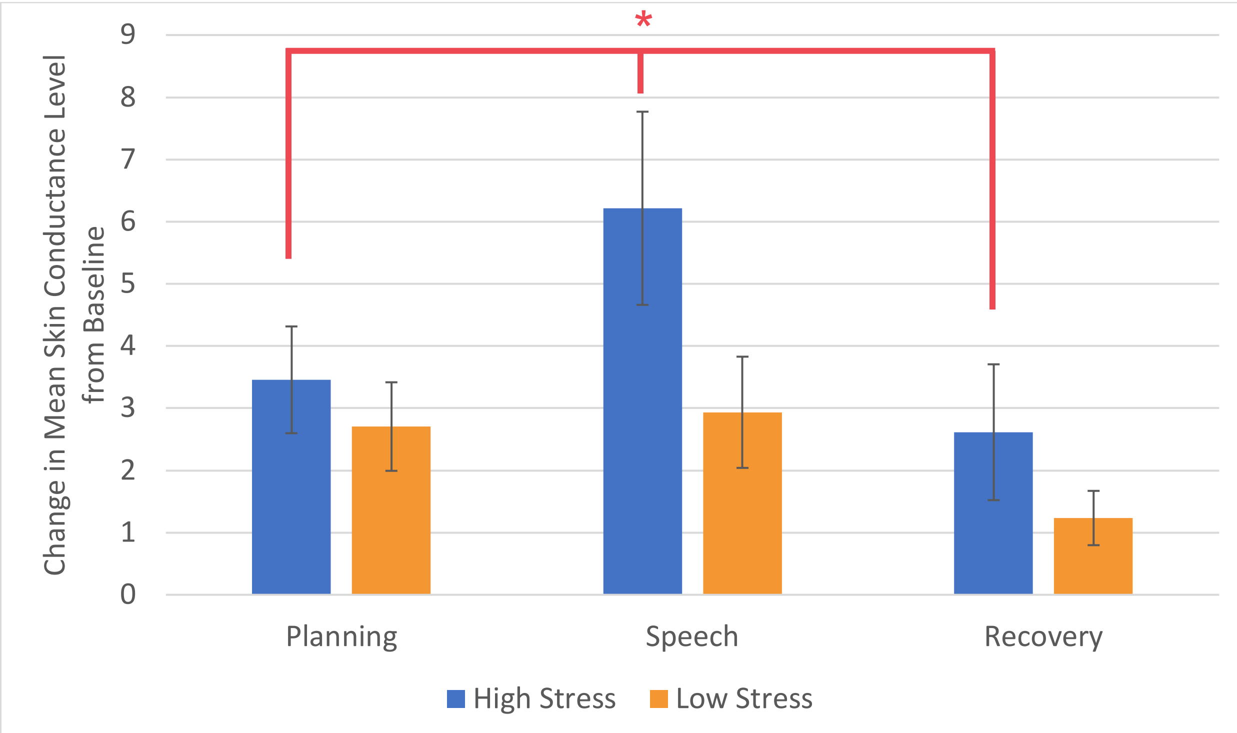

Figure 5. Between- and within-group differences in mean skin conductance level change scores across the 3 experimental conditions (baseline is not shown, as baseline skin conductance level was used to calculate change scores). Error bars represent standard error. Asterisks represent statistically significant differences ($p<.05$).

During the speech task, there were no between-group differences in skin conductance level change scores in the spontaneous (high stress: M=6.7128, low stress: M=2.8377; *W*=14.0; *p*=.121) or questions (high stress: M=5.2430, low stress: M=2.1260; *W*=13.0; *p*=.094) portions. However, skin conductance level change scores were significantly higher in the high stress (*W*=3.0, *p*=.036) and low stress (*W*=.000; *p*=.018) groups during the spontaneous portion of the speech condition than during the questions portion. See Figure 6.

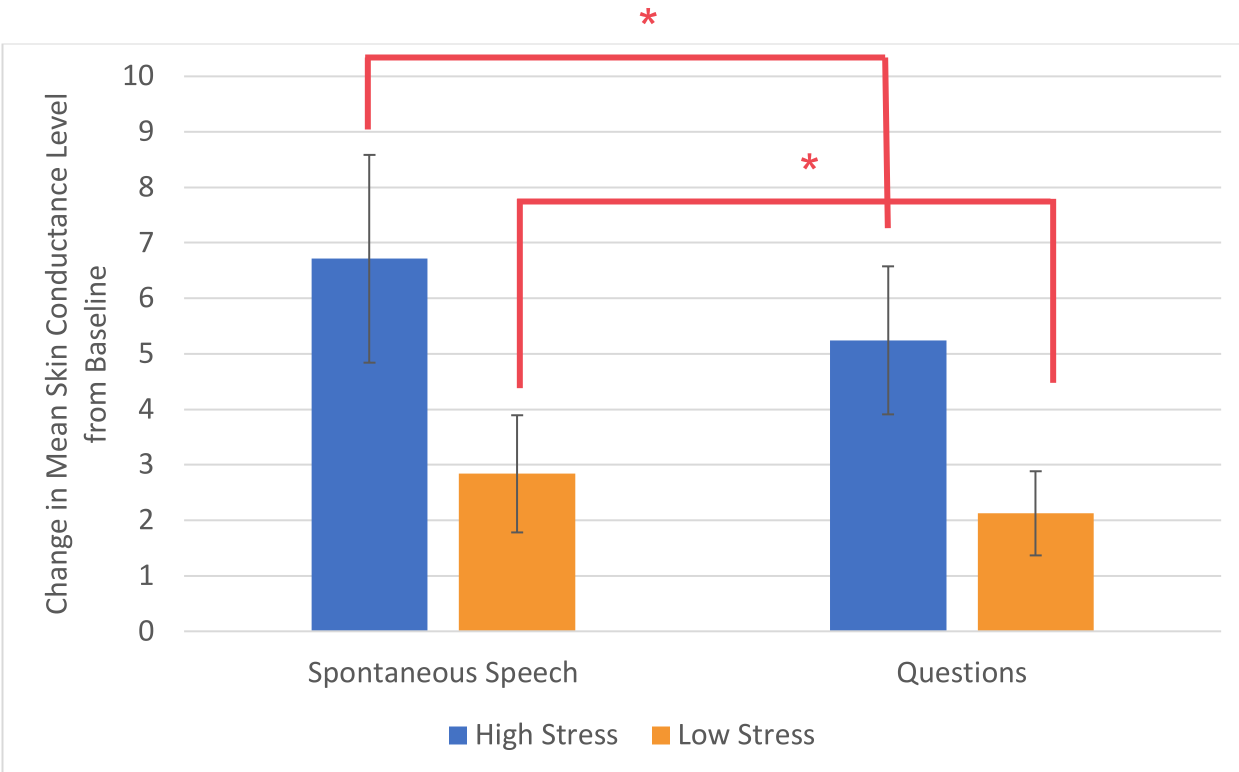

Figure 6. Between- and within-group differences in mean skin conductance level change scores for the two portions of the speech task. Error bars represent standard error. Asterisks represent statistically significant differences (p<.05).

Physiological Vigilant Attention

No significant between-group differences were noted in the proportion of time spent in high vigilant attention during the baseline (high stress: M=.29688, low stress=.2975; U=16.0; p=.878), planning (high stress: M=.2835, low stress: M=.354; U=14.25; p=.505), speech (high stress: M=.30313, low stress: M=.33225; U=18.0; p=.645), or recovery (high stress: M=.31963, low stress: M=.17463; U=10.5; p=.083) conditions. See Figure 7. The high stress group did not exhibit a significant change in time spent in high vigilant attention across the 4 conditions (Q=13.0, p=.815). The low stress group exhibited a similar pattern of non-significant within-group differences (Q=5.0, p=.172). See Figure 7.

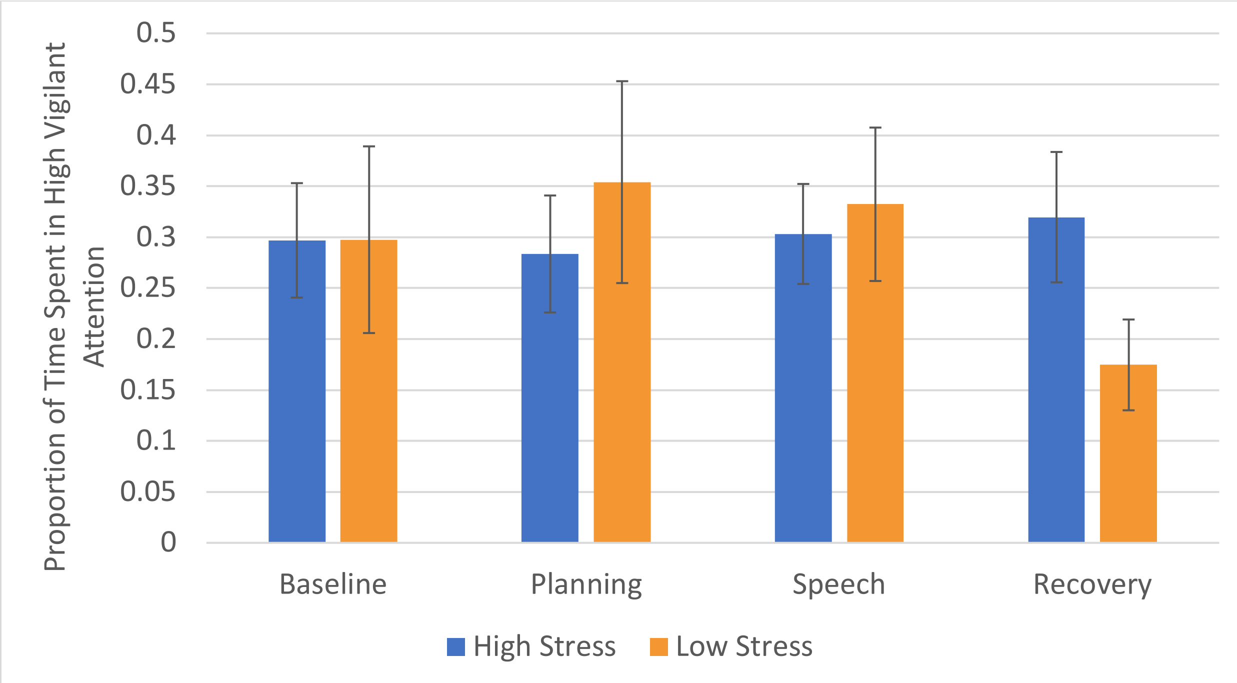

Figure 7. Between- and within-group differences for proportion of time spent in high vigilant attention, as measured by EEG. Error bars represent standard error.

Language Production

Overall mean length of C-unit was not significantly higher in the high stress group versus the low stress group (high stress: M=14.36554, low stress: M=13.77943; *U*=12.5; *p*=.161). There were also no significant between-group differences during the spontaneous (high stress: M=14.73344, low stress=13.57123; *U*=14.0; *p*328) or questions (high stress: M=13.87855, low stress: M=14.61947; *U*=13.0; *p*=.878) portions of the speech condition. The high stress group did not exhibit a significant change from the spontaneous portion to the questions portion (*W*=13.0, *p*=.484), The low stress group followed a similar pattern of non-significant differences between the two portions of the speech task (*W*=21.0, *p*=.674). See Figure 8.

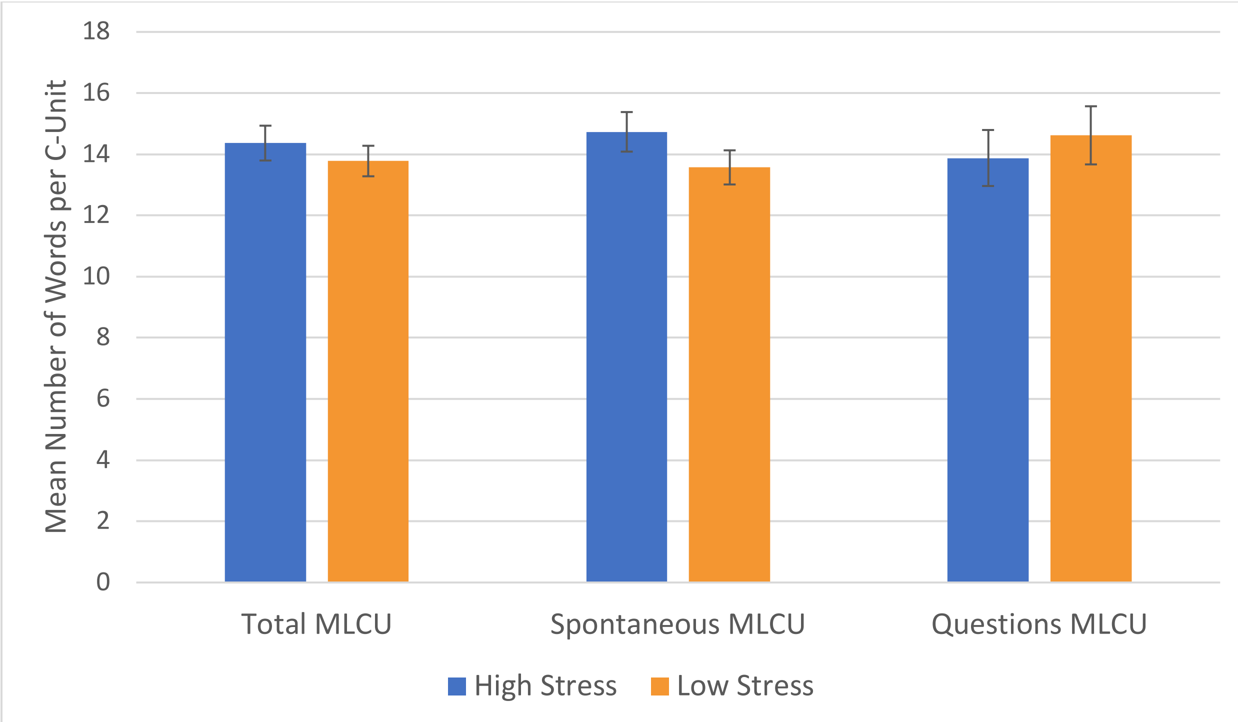

Figure 8. Between- and within-group differences for mean length of C-unit. Error bars represent standard error.

In addition, no between-group group differences were found in overall clausal density (high stress: M=1.39981, low stress: M=1.44266; *U*=18.5; *p*=.505). There were also no significant between-group differences in the spontaneous portion of the speech condition (high stress: M=1.40478, low stress=1.34406; *U*=22.0; *p*=1.0). However, the low stress group exhibited a significantly higher clausal density during the questions portion of the task (high stress: M=1.32534, low stress: M=1.53589; *U*=5.25; *p*=.038). The low stress group also exhibited a significant increase in clausal density from the spontaneous portion to the questions portion (W=36.0, p=.012), whereas the high stress group did not exhibit a significant within-group difference (W=12.0, p=.401). See Figure 9.

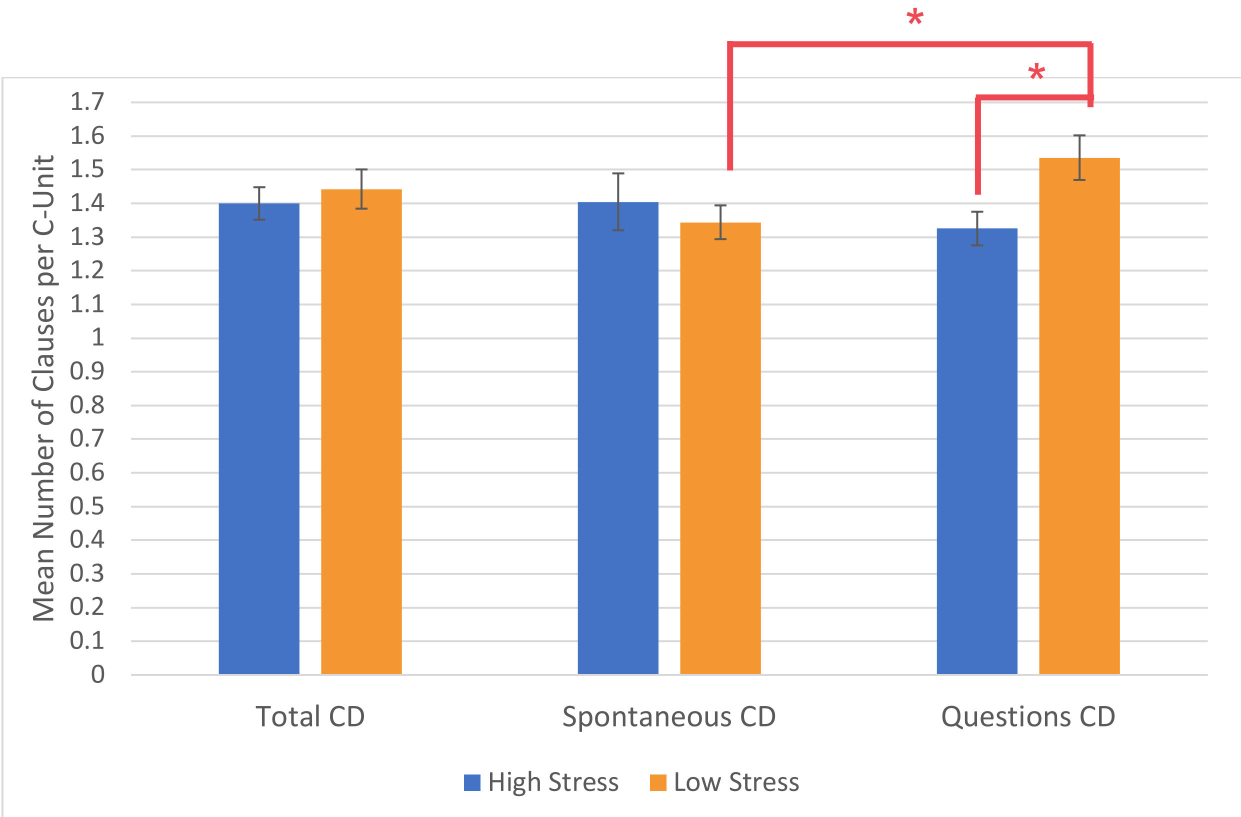

Figure 9. Between- and within-group differences for clausal density. Error bars represent standard error. Asterisks represent statistically significant differences (p<.05).

Discussion

In this study, we asked several research questions regarding the effects of stress on perceived anxiety, physiological arousal, cognitive attention, and language production: 1) did the high stress group report greater anxiety following their task than the low stress group? 2) did the high stress group exhibit higher skin conductance levels during their task than the low stress group? 3) did the high stress group spend more time in a state of high vigilant attention during the task than the low stress group? 4) did the high stress group produce less complex language than that of the low stress group?

Regarding question 1, the high stress group did not report higher engagement, distress, or worry, as measured by the Dundee Stress State Questionnaire-Short Form, than the low stress group. In addition, there was no significant change in engagement, distress, or worry in either group from pre-speech condition to post-speech condition. This result could indicate that the speech condition was not stressful enough to induce anxiety that participants were able to perceive. The original Trier Social Stress Test involves a committee of at least 3 evaluators, whereas the modified version employed in this study involved only one. As a result, participants in the high stress group may have experienced less social-evaluative threat due to the presence of only one evaluator. However, research has indicated that only the presence of a video camera is sufficient to create social-evaluative threat (Marsland, Manuck, Fazzari, Stewart, & Rabin, 1995; Cohen et al., 2000). In addition, most versions of the Trier Social Stress Test employ a surprise mental calculation task to induce further anxiety and physiological arousal (Allen, Kennedy, Cryan, Dinan, & Clarke, 2014; Allen et al., 2017). This modified version of the task may not have induced as much physiological arousal because of the omission of that portion. Another possibility is that participants did not want to disclose the anxiety they felt, thus reporting lower anxiety levels. Yet another possible interpretation for this null finding is that participants completed the Dundee Stress State Questionnaire-Short Form, after they had already completed the speech condition. Although physiological data was collected in real time, the self-report data could only be collected after the condition was over. Although participants completed the measure immediately after completing their speech, it is still possible that their perception of any anxiety experienced would not be as salient after the social-evaluative threat has been removed. Still another explanation is that the sample size of both groups was not large enough to detect any significant differences in self-reported anxiety.

Regarding question 2, the high stress group exhibited a significant change in mean skin conductance level from baseline to the speech condition. Mean skin conductance level in the low stress group did not significantly change from baseline to any of the other 3 conditions. Although the high stress group did not exhibit higher skin conductance level overall, the change within the group indicates that the modified Trier Social Stress Test did induce stress-related physiological arousal. The sample size may not have been large enough to detect differences between the groups, or the lower skin conductance levels recorded in the high stress group during planning and recovery may have resulted in a lower overall mean change score.

Additional analyses revealed that participants in both groups exhibited higher skin conductance level change scores during the spontaneous portion than the questions portion of the speaking condition. This could indicate that the spontaneous portion of the speaking condition was more stressful for participants in either group, perhaps due to the fact that participants were required to perform a monologue with little interaction with the experimenter during this time. The question-and-answer portion may have been less stressful for participants because it involved some form of interaction with the experimenter. Perhaps the simple act of speaking alone in front of an audience is sufficient to induce stress-related physiological arousal, even if the environment in which the individual speaks is relatively free of social-evaluative threat. If the entire speech condition in the low stress group had been a conversation or a question-and-answer session, more stark differences in mean skin conductance level may have been observed.

Regarding question 3, the high stress group did not spend more time in a state of high vigilant attention than the low stress group. There also was no significant change in the amount of time spent in high vigilant attention across conditions in either group. Again, this null finding could be a result of the small size of each experimental group. However, another explanation is that EEG-measured high vigilant attention is not responsive to stressful communication situations. We know that the modified Trier Social Stress Test induced some stress-related physiological arousal due to the significant changes in skin conductance level in the high stress group. Thus, we can reasonably presume that EEG-measured vigilant attention would follow a similar pattern of change in the high stress group if it were a measure of stress-related physiological changes. As this was not the case, perhaps this measure is more indicative of the cognitive effort required for a task rather than the anxiety associated with it. As all participants in this sample were native English speakers with no history of speech or language disorders, perhaps the simple act of speaking did not provided an adequate challenge to induce more time spent in high vigilant attention. The original Trier Social Stress Test included a mental calculation task along with a speaking task (Allen et al., 2017); perhaps if this portion of the test had been included in this study, changes in high vigilant attention may have been noted.

Regarding question 4, there were no significant differences in overall mean length of C-unit between the high stress and low stress groups. In addition, neither group exhibited a significant change in mean length of C-unit from the spontaneous to the questions portion of the speech condition. As with all previous dependent variables, the small sample size could have been a factor in this null finding. However, this may also indicate that a stressful communication event does not have a meaningful effect on individuals' gross language output. Additionally, only meaningful words were counted towards an individual's mean length of C-unit. Further research may indicate that, while gross meaningful language output may remain unaffected by stress, individuals under duress may produce more filler words (e.g., "um", "uh") or exhibit more false starts (e.g., "My greatest strengths are…I think that my greatest strengths are…").

The low stress group did exhibit a significantly higher clausal density than the high stress group during the question portion of the speech condition. In addition, the low stress group exhibited a significant increase in clausal density between the spontaneous and question portions of the speech condition, while the high stress group did not. One possible conclusion we can draw is that the high stress group exhibited a lower clausal density in this condition because they were experiencing higher levels of stress. Skin conductance level data indicated that the high stress group experienced stress-related physiological arousal during the speech condition, whereas the low stress group did not experience any significant change in physiological arousal. Thus, stressful communication events may adversely impact the syntactic complexity of an individual's language output. However, additional analysis revealed that participants in the high stress group exhibited a significantly higher skin conductance level change score during the spontaneous portion than during the questions portion of the condition, as did the low stress group. This finding leads us to conclude that higher physiological arousal (and thus, greater stress) may not be the cause of the difference in clausal density between the groups during the questions portion.

Another possible explanation for this difference is related to preparation time. Both groups were given time to prepare their thoughts for the spontaneous portion of their speech. However, participants in the high stress group were unaware that they would be asked questions at all., and participants in the low stress group were given the exact questions to be asked and time to prepare their responses during the planning period. Participants in the low stress group may then have exhibited more syntactic complexity in their question responses simply because they were given time to prepare them. It is important to again note that a significant difference in clausal density was detected only during the portion of the speech condition where there was a difference in preparation time. Therefore, we may conclude from this finding that preparation time is more salient to the syntactic complexity of language output than stress-related physiological arousal.

In conclusion, the stress protocol employed in this study induced some level of stress as measured by the participants' higher level of physiological arousal but did not affect time spent in high vigilant attention. Gross language output appeared to be unaffected by a stressful communication task, whereas syntactic complexity appeared to be adversely affected when participants were asked to respond to unexpected questions. However, the inability to prepare a response may also have been the reason for less syntactic complexity in the high stress group in this study.

Future studies may conduct a similar experiment with a larger number of participants in order to better detect group differences. In addition, a different self-report measure of anxiety may be employed to better capture the effects of stressful communication on participants' perception of anxiety. There may also be communication tasks other than the Trier Social Stress Test that may induce greater anxiety and have stronger effects on language output. For example, a communication task requiring participants to speak on divisive or controversial topics, as well as implying that there will be real-world consequences to their speech (e.g., posting the participants' thoughts online), may induce more perceived anxiety and physiological arousal. In addition, changing the topic of the speech may promote more vigilant attention, as participants may need to exert more cognitive effort to prepare their thoughts. Future studies may also investigate different methods of quantifying the effect of stress on language. For instance, further study may indicate that stress impacts the amount of disfluencies (i.e., non-meaningful words, such as “um” and “uh”) or syntactic errors (e.g., incorrect subject-verb agreement) in a person’s language.

It is important to study the effects of stress on our bodies, minds, and language, as so many important communication effects in our lives take place under stress. Further research regarding this topic may reveal ways in which the negative effects of stress can be ameliorated and provide methods of producing proficient language even under stress. In addition, this topic may be studied in clinical populations, such as individuals who stutter, as these populations may experience even more profound effects of stress in communication scenarios. There are still many questions to be answered regarding the relationship between stress, anxiety, arousal, attention, and language.

Appendix A

Modified Trier Social Stress Test Questions

"What are your personal strengths?"

"What are your major shortcomings?"

"Do you have enemies? Why?"

"What do you think of teamwork?"

Control Questions

"What are the best parts about your dream job?"

"What do you think could be some downsides to your dream job?"

"Do you think there are any obstacles to you finding your dream job?"

"Would you prefer to work individually or with a team?"

Appendix B

DSSQ-3 STATE QUESTIONNAIRE

PRE-TASK QUESTIONNAIRE

Instructions. This questionnaire is concerned with your feelings and thoughts at the moment. Please answer **every** question, even if you find it difficult. Answer, as honestly as you can, what is true of **you**. Please do not choose a reply just because it seems like the 'right thing to say'. Your answers will be kept entirely confidential. Also, be sure to answer according to how you feel **AT THE MOMENT**. Don't just put down how you usually feel. You should try and work quite quickly: there is no need to think very hard about the answers. The first answer you think of is usually the best.

For each statement, circle an answer from 0 to 4, so as to indicate how accurately it describes your feelings **AT THE MOMENT**.

Definitely false = 0, Somewhat false = 1,
Neither true nor false = 2, Somewhat true = 3, Definitely true = 4

1. I feel concerned about the impression I am making.	0	1	2	3	4
2. I feel relaxed.	0	1	2	3	4
3. The content of the task will be dull.	0	1	2	3	4
4. I am thinking about how other people might judge my performance.	0	1	2	3	4
5. I am determined to succeed on the task.	0	1	2	3	4
6. I feel tense.	0	1	2	3	4
7. I am worried about what other people think of me.	0	1	2	3	4
8. I am thinking about how I would feel if I were told how I performed	0	1	2	3	4
9. Generally, I feel in control of things.	0	1	2	3	4
10. I am reflecting about myself.	0	1	2	3	4
11. My attention will be directed towards the task.	0	1	2	3	4
12. I am thinking deeply about myself.	0	1	2	3	4
13. I feel energetic.	0	1	2	3	4
14. I am thinking about things that happened to me in the past	0	1	2	3	4
15. I am thinking about how other people might perform on this task	0	1	2	3	4
16. I am thinking about something that happened earlier today.	0	1	2	3	4
17. I expect that the task will be too difficult for me.	0	1	2	3	4
18. I will find it hard to keep my concentration on the task.	0	1	2	3	4
19. I am thinking about personal concerns and interests.	0	1	2	3	4
20. I feel confident about my performance.	0	1	2	3	4
21. I am examining my motives.	0	1	2	3	4
22. I can handle any difficulties I may encounter	0	1	2	3	4
23. I am thinking about how I have dealt with similar tasks in the past	0	1	2	3	4
24. I am reflecting on my reasons for doing the task	0	1	2	3	4
25. I am motivated to try hard at the task.	0	1	2	3	4
26. I am thinking about things important to me.	0	1	2	3	4
27. I feel uneasy.	0	1	2	3	4
28. I feel tired.	0	1	2	3	4
29. I feel that I cannot deal with the situation effectively.	0	1	2	3	4
30. I feel bored.	0	1	2	3	4

DSSQ-3 STATE QUESTIONNAIRE

POST-TASK QUESTIONNAIRE

Instructions. This questionnaire is concerned with your feelings and thoughts while you were performing the task. Please answer **every** question, even if you find it difficult. Answer, as honestly as you can, what is true of **you**. Please do not choose a reply just because it seems like the 'right thing to say'. Your answers will be kept entirely confidential. Also, be sure to answer according to how you felt **WHILE PERFORMING THE TASK**. Don't just put down how you usually feel. You should try and work quite quickly: there is no need to think very hard about the answers. The first answer you think of is usually the best.

For each statement, circle an answer from 0 to 4, so as to indicate how accurately it describes your feelings **WHILE PERFORMING THE TASK**.

Definitely false = 0, Somewhat false = 1,
Neither true nor false = 2, Somewhat true = 3, Definitely true = 4

1. I felt concerned about the impression I am making.	0	1	2	3	4
2. I felt relaxed.	0	1	2	3	4
3. The content of the task was dull.	0	1	2	3	4
4. I thought about how other people might judge my performance	0	1	2	3	4
5. I was determined to succeed on the task.	0	1	2	3	4
6. I felt tense.	0	1	2	3	4
7. I was worried about what other people think of me.	0	1	2	3	4
8. I thought about how I would felt if I were told how I performed	0	1	2	3	4
9. Generally, I felt in control of things.	0	1	2	3	4
10. I reflected about myself.	0	1	2	3	4
11. My attention was directed towards the task.	0	1	2	3	4
12. I thought deeply about myself.	0	1	2	3	4
13. I felt energetic.	0	1	2	3	4
14. I thought about things that happened to me in the past	0	1	2	3	4
15. I thought about how other people might perform on this task	0	1	2	3	4
16. I thought about something that happened earlier today.	0	1	2	3	4
17. I found the task was too difficult for me.	0	1	2	3	4
18. I found it hard to keep my concentration on the task.	0	1	2	3	4
19. I thought about personal concerns and interests.	0	1	2	3	4
20. I felt confident about my performance.	0	1	2	3	4
21. I examined my motives.	0	1	2	3	4
22. I felt like I could handle any difficulties I encountered	0	1	2	3	4
23. I thought about how I have dealt with similar tasks in the past	0	1	2	3	4
24. I reflected on my reasons for doing the task	0	1	2	3	4
25. I was motivated to try hard at the task.	0	1	2	3	4
26. I thought about things important to me.	0	1	2	3	4
27. I felt uneasy.	0	1	2	3	4
28. I felt tired.	0	1	2	3	4
29. I felt that I could not deal with the situation effectively.	0	1	2	3	4
30. I felt bored.	0	1	2	3	4

Appendix C

Rules for segmenting utterances:

- Start a new utterance whenever the speaker uses a coordinating conjunction (for, and, nor, but, or, yet, so) followed by an independent clause (see definition of independent clause below)
    - Independent clauses have a subject and verb and can stand alone as sentences
        - E.g., "So I know I would be good at that / but I need more time to learn" would be segmented into 2 utterances, marked by a slash
        - As opposed to "So I know I would be good at that but need more time to learn" would be counted as 1 utterance, as what follows the conjunction does not have a subject and verb
- EXCEPTION: sentence fragments (i.e., utterances without a subject and verb) can be counted as utterances IF they are in response to a question (e.g., "What are you greatest strengths?" "Hard work and determination") or if the speaker's tone/pausing indicates a complete thought

Rules for mazing:

- Any words that are not meaningful to the utterance are "mazed", or put in parentheses, to indicate that they will not be included in the final count
- Filler words ("uh", "um", "you know", etc.) should all be mazed
    - NOTE: "like" can be either a filler word (e.g., "So (like) that would be my dream job") or a word used to connect to phrases (e.g., "A location like that would be nice" – only maze "like" in the first instance

- False starts should also be mazed – this is when the speaker starts an utterance but then abandons it and starts the sentence over
    - E.g., "(And so I think that's) I know that this is a good career")
- After initial mazing attempts, read through each utterance to see if it makes logical sense and is grammatically a sentence with all the mazed words omitted

Rules for counting clauses:

- An independent clause, in its simplest form, contains a subject and a verb
- A dependent clause also contains a subject and a verb, but it also contains a subordinating conjunction which prevents it from standing alone as a sentence
    - Examples of subordinating conjunctions: after, although, because, even though, while, since, before
    - E.g., "I would really like to work in a hospital <u>because I think it would be a good challenge for me"</u>
        - The underlined portion is a dependent clause, so the utterance above would have 2 clauses (the first, and independent clause, and the second clause)

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