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INTONATION PROCESSING IN INDIVIDUALS WITH PARKINSON'S DISEASE

by

Alanna Nissa Friedman

Bachelor of Arts, University of Manitoba, 2009

A Thesis

Submitted to the Graduate Faculty

of the

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In partial fulfillment of the requirements

for the degree of

Master of Science in Speech-Language Pathology

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This thesis, submitted by Alanna Nissa Friedman in partial fulfillment of the requirements for the Degree of Master of Science from the University of North Dakota, has been read by the Faculty Advisory Committee under whom the work has been done, and is hereby approved.

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This thesis is being submitted by the appointed advisory committee as having met all of the requirements of the Graduate School at the University of North Dakota and is hereby approved.

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Dr. Wayne Swisher, PhD
Dean of the Graduate School

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July 19, 2012

Title	Intonation processing in individuals with Parkinson's disease
Department	Communication Sciences and Disorders
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Alanna Friedman
July 19, 2012

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I wish to express my sincere appreciation to my wonderful family, friends, and professors, without whom I would not have been able to reach my goals and achieve my success in graduate school.

ABSTRACT

Parkinson’s disease is a progressive neurogenerative disease cased by death of dopaminergic neurons in structures that make up the basal ganglia. Functionally the basal ganglia are involved in motor, cognition, and emotion control. Researchers have provided evidence that damage to the basal ganglia can result in deficient perception and production of intonation in non-emotional (Cheang et al., 2004; Ma et al., 2007) and emotional (e.g., Breitenstein et al., 1998; Cancelliere & Kertesz, 1990) contexts.

Studies on perception of intonation have provided evidence that patients with Parkinson’s disease have difficulty perceiving intonation in emotional and non-emotional contexts. Perceptual research findings also suggest that individuals with Parkinson’s disease have difficulty discriminating intonation patterns in non-emotional and emotional speech and that the deficit is related to higher-level language and cognitive processing respectively (Lloyd, 1999; Pell, 2006; Scott et al., 1984).

In contrast to the evidence for the perceptual studies that the basis of the deficit is related to higher level processing, production studies suggest the deficits are motor based (Mennen, 2008). Studies on of both the production of intonation in non-emotional and emotional speech have presented evidence to suggest that individuals with Parkinson’s disease have reduced fundamental frequency variability and difficulty increasing final pitch (Cheang et al., 2007; Harel et al., 2004). Pitch raising is more difficult than pitch lowering, which indicates that production deficits may be motor based.

The difficulty with these studies however is that they look only at the phonetic or lower level processing issues and do not account for the role of the phonological aspects of language.

The purpose of the current study was to determine if perceptual and production deficits of intonation in both non-emotional and emotional contexts were present among the same individuals with Parkinson's disease and if so, whether these deficits are due to linguistic or non-linguistic factors. With the main objective of the study was to determine if the production deficits were solely motor based, or if, like the perceptual deficits, there was a higher-level processing component.

Thirteen patients with Parkinson's disease and 11 healthy controls participated in the study and performed perceptual and production tasks. The perception and production tasks contained non-emotional and emotional stimuli. The perceptual data included participant response, to determine if the results were greater than chance. The production data were analyzed according to pitch range and duration.

The results showed significant differences between the individuals with Parkinson's disease and healthy controls groups for the production of happy utterances and questions. Slight significance was presented for the perceptual data of incorrect emotional responses, however this may have been due to outliers. These results indicate that the deficits patients with Parkinson's disease present with are due to motor-based impairments.

CHAPTER I

INTRODUCTION

Parkinson's disease is a progressive neurodegenerative disease caused by the death of dopaminergic neurons in substantia nigra, a nucleus in the midbrain (mesencephalon). The substantia nigra is one of a group of nuclei including the striatum (caudate and putamen), globus pallidus, and subthalamic nucleus that forms the basal ganglia (Bhatnagar, 2008). Components of the basal ganglia are connected to the thalamus and multiple cortical sites, most of which are in the frontal lobe (Brookshire, 2007). Functionally, the basal ganglia are involved in cognition and emotion control (Nolte, 2002). Damage to them has been reported to be accompanied by abnormal production and perception of aspects of intonation in non-emotional (Cheang et al., 2004; Ma et al., 2007) and emotional (e.g., Breitenstein et al., 1998; Cancelliere & Kertesz, 1990) contexts.

Research on patients with Parkinson's disease has shown these individuals to be deficient at perceiving intonation in non-emotional and emotional contexts. These deficiencies are related to higher-level language processing and higher-level cognitive processing respectively. Studies on the perception of intonation in non-emotional contexts have shown that patients with Parkinson's disease are significantly impaired at discriminating intonation patterns and lexical stress of utterances when compared to healthy controls (Lloyd, 1999; Scott et al., 1984). Individuals with Parkinson's disease have difficulty discriminating whether intonation patterns produced by healthy individuals are the same or different, and at determining if sentences are produced as questions or statements (Lloyd, 1999; Scott et al., 1984). Findings like these suggest that the problems these patients have with intonation may be related to higher-level language processing.

Perceptual studies of intonation in an emotional context suggest a conclusion similar to that of studies in a non-emotional context; however, the difficulties are related to higher-level cognitive processing not language processing. Research suggests that patients with Parkinson's disease who were cognitively impaired have greater difficulty discriminating emotional speech compared to healthy controls and cognitively intact patients with Parkinson's disease (Benke et al., 1998; Breitenstein et al., 2001). Studies that looked at cognitively intact individuals with Parkinson's disease found similar results, that discrimination of intonation in emotional speech was deficient (Pell et al., 2003).

Unlike the findings from perceptual research, studies of the production of intonation in non-emotional and emotional contexts have provided evidence that the deficit is motor-based. Some studies indicate that these patients have impaired ability to produce phonetic but not phonologic aspects of intonation in non-emotional speech (Ma et al., 2010; Mennen et al., 2008; Pell et al., 2006). Research has presented evidence that patients with Parkinson's disease exhibit lower than normal fundamental frequency (F_0) variability, as well as difficulty producing terminal rising F_0 contours to mark echo questions (Harel et al., 2004; Pell et al., 2006). Given that pitch raising is more difficult than pitch lowering, this finding suggests that the problem for these patients may be motor based.

Similar to the findings from production studies on intonation in non-emotional contexts, difficulties with intonation in emotional contexts are believed to be motor based. The productions of intonation in emotional speech productions of patients with Parkinson's disease have been acoustically analyzed. Productions were measured according to mean F_0, mean amplitude, speech rate, F_0 variability, and amplitude variability. The researchers found these individuals were impaired across all of the measures when compared to healthy controls (Pell et al., 2007). Similarly, Möbes et al. (2008) found that individuals with Parkinson's disease had an impaired ability to produce intonation in emotional contexts when compared to healthy controls. These findings were similar to the studies on intonation in non-emotional speech and indicate that the problem may be motor based.

The problem with the studies regarding the production of intonation in emotional and non-emotional speech is that they examined the deficits at a low level, and did not investigate the higher-level of deficit that may be occurring. The non-emotional studies acoustic measures were analyzed for the role of lower level phonetic processing, the possible role of the phonological aspects of language were not considered. The organization of pitch patterns in the phonological system is referred to as nuclear tone (Snow, 2006). The nuclear tone is found within the F_0 contour; the vocalic nucleus is the beginning of voicing and the nuclear tone (final measureable F_0) and is found at the final boundary of the utterance (Balog et al., 2007; Snow, 2000). Nuclear tones can be measured to identify speech patterns for intonation in emotional and non-emotional speech. These nuclear tones are perceived as the falling and rising patterns of intonation in non-emotional speech (i.e. statements versus questions) and the rising and slight falling patterns (i.e. happy versus sad) of intonation in emotional speech (Snow, 2000). The nuclear tones that are perceived are also produced; it is these measures that can be used to identify deficits in the perceptions and productions of patients with Parkinson's disease. Identifying deficits in the perception and production of intonation in emotional and non-emotional contexts will allow for further information regarding the basis of intonation deficit in Parkinson's disease.

The purpose of this study was to determine whether the basis of the intonation processing problems for patients with Parkinson's disease is related to linguistic or non-linguistic factors. The main objectives of the study were to determine if the production deficits were solely motor based, or if, like the perceptual deficits, there was a higher-level processing component. The following specific questions were explored:

1) Are deficits of intonation in non-emotional contexts due to higher-level language processing?

2) Are deficits of intonation in emotional contexts due to higher-level cognitive processing?

3) Are production deficits found in both intonation of emotional speech and intonation of non-emotional speech?

4) Are production deficits of intonation due solely to the motor problems associated with Parkinson's disease?

5) Are there differences in the duration of utterances between healthy controls and individuals with Parkinson's disease?

CHAPTER II

LITERATURE REVIEW

Perception of Intonation

The perception of intonation in non-emotional and emotional intonation is deficient among individuals with Parkinson's disease (Scott et al., 1984; Benke et al., 1998; Lloyd, 1999; Breitenstein, 2001).

Few studies have been conducted on perception of intonation in non-emotional contexts. The evidence from these studies provides conflicting evidence that patients with Parkinson's disease have difficulties perceiving intonation in non-emotional contexts. Pell (1996) compared 11 patients with Parkinson's disease and 11 healthy controls, participants had to complete two tasks. Participants had to discriminate intonation patterns, and then they had to identify intonation patterns of non-emotional speech. Pell found that there was no significant difference between the abilities of the participants with Parkinson's disease and the healthy controls.

In contrast, Scott, Caird, and Williams (1984) presented evidence that patients with Parkinson's disease had difficulty discriminating differing intonation patterns when compared with healthy controls. The participants in the study were asked to discriminate whether sentences that were presented were the same or different. The stimuli were presented in pairs, one with a neutral intonation pattern and the other with emphasized stress. The results of the study indicated that the patients with Parkinson's disease had difficulty discriminating the two intonation patterns. Similarly, Lloyd (1999) presented evidence that individuals with Parkinson's disease have difficulty perceiving intonation in non-emotional contexts. The participants had to identify the intonation of sentences (i.e. questions or statements); the responses were provided for each sentence. The participants with Parkinson's disease did significantly worse than the healthy controls at identifying the difference. In contrast, in same study when individuals with Parkinson's disease were asked to discriminate whether or not sentences had matching intonation patterns, they performed comparably to the healthy controls. This suggests that individuals with Parkinson's disease may only have difficulty with certain aspects of non-emotional intonation perception. Even within one study there is conflicting data regarding deficits in perception of intonation in non-emotional speech.

The evidence for the perception of intonation in non-emotional contexts has conflicting data with few studies. In contrast, a number of studies on the perception intonation in emotional contexts, all provide evidence that individuals with Parkinson's disease are deficient in this area. One such study, completed by Breitenstein, Daum, and Ackermann (1998), used a standardized test battery to compare 14 patients with Parkinson's disease, 32 patients with focal cerebral lesions in the cortex, and two groups of healthy controls. One of the subtests looked at participants' ability to discriminate intonation in emotional contexts. Patients with Parkinson's disease and those with right focal cortical lesions performed worse on the discrimination task than those with left cortical lesions and the healthy controls. This evidence indicates that the basal ganglia, affected in Parkinson's disease results in similar emotional deficits as individuals with right hemisphere damage; the right hemisphere has been linked to emotion processing.

Breitenstein et al. (2001) also studied the ability to discriminate intonation in emotional speech in a variety of contexts, such as. The researchers compared 20 patients with Parkinson's disease and 16 healthy controls, in order to determine what factors contribute to the impaired ability of patients with Parkinson's disease to perceive intonation in emotional speech. The researchers analyzed the correlation between responses for the intonation tasks and the cognitive tasks. They found a significant correlation between the intonation and cognitive task responses. These findings indicate that the impaired ability to perceive intonation in emotional contexts may be related to cognitive deficits. These findings are consistent with the findings from the earlier study; that individuals with Parkinson's disease have difficulty perceiving intonation in emotional speech and that these deficits may be related deficits in cognitive processing. Similarly, Pell and Leonard (2003) looked at twenty-one patients with Parkinson's disease who had a reduced ability to perceive emotional intonation in a variety of perceptual tasks (discrimination, identification, and emotional feature rating), which provides further evidence that patients with Parkinson's disease have deficits in perceiving intonation in emotional speech.

Ariatti et al. (2008) examined 27 cognitively intact patients with Parkinson's disease and found that they were deficient in perceiving intonation in emotional speech. The researchers found that the deficit may be due to higher level cognitive processing of emotion. Further evidence comes from Dara et al. (2008) who examined 16 patients with Parkinson's disease and their ability to perceive intonation cues in emotional speech.

They presented the patients with three tasks that evaluated their ability to process emotion from intonation features alone and a fourth task which evaluated emotional processing with semantic cues. The semantically dependent task was included as a control and compared to the other three tasks to determine if the patients had greater difficulty perceiving emotional speech when reliance on semantics was not an option. The patients with Parkinson's disease did significantly worse on the three tasks that lacked semantic cues when compared to healthy controls but, they were able to identify the emotions when provided semantic cues. These findings indicate that the patients with Parkinson's disease had difficulty perceiving intonation cues in emotional speech that lacked semantic information. The patients in this study were all cognitively intact and still performed poorly on these tasks, therefore presenting evidence that patients with Parkinson's disease have deficits understanding emotional speech from intonation alone.

In contrast to the findings presented, Mitchell et al. (2009) examined 33 patients with Parkinson's disease and 33 healthy controls. The participants were auditorily administered an emotional n-back task (a continuous performance tasks that is administered to promote cerebral activity) and a cognitive n-back task. For the emotional task, participants had to determine whether sentences conveyed 'happiness' or 'sadness' based on intonation patterns. The findings that were presented by the researchers showed that there was no significant difference between the Parkinson's patients and the healthy controls. The researchers did, however, find a significant difference between the Parkinson's patients and the healthy controls on the cognitive task, which indicates that the deficit may be related to higher-level cognitive deficits and not emotional deficits.

Research conducted more recently by Paulmann et al. (2010) has shown through ERP evidence that damage to the basal ganglia, the area damaged by Parkinson's disease, causes difficulty with emotional processing. This information was further confirmed by Paulmann et al. (2012), who provided evidence regarding aspects of intonation in emotional speech that are deficient in patients with Parkinson's disease, which are processed by circuitry related to the basal ganglia. Both of these studies provide evidence that patients with Parkinson's disease have difficulty perceiving intonation in emotional contexts.

The problem is that few studies have looked at intonation in non-emotional and emotional contexts; the majority of the studies cited above did not look at whether deficits with respect to the perception of intonation in non-emotional and emotional contexts were present in the same group of individuals. The majority of studies looked at the two types of deficits separately, if at all. This study will look at the perception of intonation in non-emotional and emotional contexts in the same individuals with Parkinson's disease.

Production of Intonation

The production of intonation is deficient in patients with Parkinson's disease. Some studies have shown that the problems that these patients have are motor-based; however, the analyses that have been completed have not looked at the components of speech production associated with higher-level processing.

Studies have provided evidence that individuals with Parkinson's disease have difficulty producing intonation in non-emotional contexts. Harel et al. (2004) conducted a longitudinal study of an individual with Parkinson's disease, which found that the individual exhibited lower than normal fundamental frequency (F_0) variability. Other studies have presented similar evidence from studies of larger groups of individuals with Parkinson's disease (Cheang et al., 2004). Cheang and Pell (2007) presented similar findings; 21 patients with Parkinson's disease and 21 healthy controls were compared for their ability to produce differing non-emotional intonation speech tasks. The measurements of the productions included amplitude, fundamental frequency (F_0), and duration of non-emotional utterances. The study findings indicated that patients with Parkinson's disease had a significant reduction in amplitude, difference in average F_0 between the groups, and a significant difference in duration in non-emotional utterances. The researchers related the deficits the patients with Parkinson's disease had to the motor impairments associated with the disease.

Another study, which provides evidence that patients with Parkinson's disease are deficient in producing non-emotional intonation, comes from Mennen and colleagues (2008). This study examined the intonation speech patterns of two males with Parkinson's disease while they were reading. The study found that the patients had no difficulty with their production of intonation; however, the authors also indicate that the difficulties observed among other Parkinson's patients might be due to a disturbance in the lower level of phonetic planning or initial planning of speech.

Ma et al. (2010) conducted a study on native Chinese speakers with Parkinson's disease. The 14 patients with Parkinson's disease produced questions and statements, which were analyzed to determine the acoustic differences between these productions. The productions were recorded and analyzed by the researchers. The recordings were then presented to a group of naïve healthy listeners to determine whether the patients with Parkinson's disease were producing statements or questions. The results indicated that the listeners had difficulty identifying questions versus statements produced by the patients with Parkinson's disease. The researchers indicated that the listeners relied on the final F_0 or nuclear tone to interpret the meaning of the sentences. Nuclear tones are aspects of the phonological system; this study therefore provides evidence that patients with Parkinson's disease may be deficient on a phonological level and not only a phonetic level.

All of these studies have presented evidence to support the notion that individuals with Parkinson's disease have difficulty producing intonation in non-emotional contexts; however, only one has linked the deficits to higher-level language processing.

Studies on intonation in non-emotional speech have done systematic acoustic analysis for the productions of individuals with Parkinson's and compared them to healthy controls. Acoustic analysis is not measured subjectively, but rather must be completed in a specific way to provide information regarding certain aspects of speech productions. Unlike studies on intonation in non-emotional speech, majority of studies on intonation in emotional speech

Benke, Bösch, and Andree (1998) conducted a study that was designed to determine the characteristics of the perception deficits of intonation in emotional speech and to determine if cognitive deficits play a role in the perceptual impairment of this population. The study looked at forty-eight patients with Parkinson's disease that were separated into two groups, those who had mild cognitive issues (n = 26) and those who had no cognitive issues (n = 22). Patients were asked to produce emotional speech intonation. The results showed that the patients who had the cognitive impairment had greater difficulty with the production of intonation in emotional speech when compared to the healthy controls and the cognitively intact individuals with Parkinson's disease. This study provides the evidence that processing of emotional intonation may be due to higher-level cognitive processing rather than motor deficits alone. Though this study provides evidence that higher-level processing may be a factor in the production deficits found in Parkinson's disease, the researchers did not analyze the productions of all the individuals systematically. They used a listener rating scale; in depth acoustic analysis may have shown that both groups of individuals with Parkinson's disease had deficits, which were significantly greater than the healthy controls.

The majority of the studies on production of intonation, like the Benke et al (1998) study, do not systematically analyze the productions by patients with Parkinson's disease. Pell et al. (2006), however, examined the production of emotional intonation among patients with Parkinson's disease. They had 21 English-speaking patients with Parkinson's disease produce different utterances, which varied in phonemic stress, contrastive stress, sentence mode, and emotional prosody. The recorded utterances were perceived and judged by twenty naïve listeners who were unaware of the patient's diagnosis of Parkinson's disease. The listeners perceived the utterances to be either sad or void of emotion. The authors present the idea that this may be due to the acoustic parameters of speech production. Producing 'sad' typically is lower and slower when compared to 'happy' or 'angry' emotions. The F_0 (fundamental frequency) of 'sad' utterances tends to be lower on average than those of 'happy' or 'angry' (Pell, 2001; Pell et al. 2006). These production difficulties may be in part due to motor deficits, however, they also relate to the previous findings of the perception studies. The similarity in the findings of the perceptual intonation tasks and the production tasks point to a processing problem within the basal ganglia; however, whether the difficulty is due to a cognitive/language deficit or due to an emotional deficit is still unknown because no studies have looked at production and perception of intonation in non-emotional and emotional contexts within one group of patients with Parkinson’s disease.

The difficulty with the production studies on intonation in non-emotional and emotional speech is that they have not looked at the possible link to higher-level language and cognitive processing, which may be a factor in these deficits. Most researchers relate these deficits to lower level phonetic planning or lower-level speech planning (i.e. motor impairment) without allowing for a possible relationship between perceptual deficits and production deficits.

CHAPTER III

METHODS

The study was completed in accordance with the ethical standards and criteria of the Institutional Review Board of the University of North Dakota. All participants were offered $10.00 compensation for participating in the study; many refused the offer.

Participants

All participants passed a hearing screening in accordance with the American Speech-Language-Hearing Association (ASHA) standards. The screenings were completed in a quiet room using a GSI Auto Tymp portable audiometer. Individuals with a history of language, neurological, or cognitive deficits were excluded from the study. Individuals who had visual problems that could impact the experimental task performance were also excluded.

Experimental Group

The experimental group (EG) consisted of 13 individuals with Parkinson's disease who were recruited through the Manitoba Parkinson's Society and the Grand Forks Senior Center. There were 6 males and 7 females. Patient ages ranged from 49 to 77 years with a mean of 65.8 years old. One participant was significantly younger, 10 years, than the majority of the participants, however due to length of disease she was included in the data. Participants had an average number of 13.8 years of education (8 to 20 years).

Twelve of the participants were right-handed and one was left-handed. Twelve of the participants were taking a combination carbidopa and levadopa medication, 2 were taking a secondary medication to treat their Parkinson's disease, and 1 was taking no medication for his Parkinson's disease but was taking medications for other health issues; 5 were taking medication for hypertension; 5 were taking medications for hyperlipidemia; 3 were on allergy/asthma medications; 5 were on anti-anxiety and depression medications; 1 was on medication for Diabetes; 1 was on medication for incontinence; 1 was on medication for rosacea. Medical records were reviewed to gather information regarding age of onset, type of Parkinson's disease (i.e. idiopathic or not), motor signs, information regarding hemispheric involvement, and neuropsychological test results. Participants were also asked about this information, as not all of the participants' records could be accessed.

The review of records and participant information revealed that all patients had been diagnosed with idiopathic Parkinson's disease with an average age of onset of 59.6 years old (43 to 73 years). Participants' had an average length of disease of 6.6 years (4 years to 11 years). Patients were diagnosed with idiopathic Parkinson's disease; none of the participants had a family history of Parkinson's disease. Four of the participants had bilateral motor difficulties, 3 had lateralized right-sided deficits, and 6 had lateralized left sided deficits. Information regarding hemispheric involvement was not available for all participants, however due to reported motor deficits it is presumed that 4 patients had bilateral damage, 6 had right sided damage, and 3 had left sided damage. Previous neuropsychological testing was not completed for the present group of participants, as testing is only completed once signs of deficit are noted.

Control Group

The healthy controls (HC) were 11 individuals who had no prior history of neurological or cognitive impairment. These individuals were recruited from prior studies completed through the University of North Dakota and through the Manitoba Parkinson's Society. The participants were matched to the experimental group for age, sex, and number of years of education, as closely as possible. The control group consisted of 4 males and 7 females, with a mean age of 66.1 years old (54 to 85), and years of education averaging to 14.7 years (8 to 20). Ten of the participants were right-handed and one was left-handed. All participants reportedly had no history of neurological, language, or cognitive deficits, or a diagnosis of Parkinson's disease. Four of the participants were taking high blood pressure medications; 2 were taking medication for hyperlipidemia; 2 were taking medication for anxiety.

Apparatus

A GSI Auto Tymp portable audiometer was used for all hearing screenings. A Sony DAT PDP- 125 audiotape and Tascam DA-P1 audio tape recorder attached to Harmon/Kardon loud speakers were used to present the stimuli to the participants for the perception tasks. Each participant was given two sets of response sheets, one for the emotional task and one for the non-emotional task; blank response sheets can be found in Appendix A. An AKG C 420 $^{\text{III}}$ PP attached to a Tascam DA-P1 audio tape recorder was used to record the productions of the utterances on to Sony DAT PDP-125 and DAT PDP-95 audiotapes. A Macintosh OS X computer and Praat version 1.0 software was used to analyze utterances. All statistical analysis was done using SPSS version 2.0 software.

Stimuli

Stimulus Preparation

The stimuli were obtained from a previous study (Blay, 2012). The stimuli were 100 utterances, which were used for the perception and production tasks. For the perception tasks, one set of 50 utterances was used to convey emotional (happy and sad) meanings and the other set of 50 utterances was used to convey non-emotional (statements and questions) meanings, through intonation. The production task required that participants produce the same 100 utterances they would hear in the perception task. Participants had to convey emotional (using the 50 happy and sad sentences) and non-emotional (using 50 statement and question sentences) meanings through intonation.

Stimuli

The stimuli were acquired from a previous study (Blay, 2012) and consisted of 100 utterances, 50 for intonation in emotional speech and 50 for intonation in non-emotional speech. A male native speaker of English, studying to be an actor, produced all task utterances. The utterances were 6-10 syllables in length. The utterances were randomized in the emotional (happy and sad) intonation tasks, and the non-emotional (statements and questions) intonation tasks to ensure no pattern could be identified.

The stimuli were judged by 17 novel listeners to determine if they conveyed the intended meaning. All listeners were native speakers of English, between the ages of 18 to 30. Only one of the listeners provided an incorrect judgment for the non-emotional sentences, this was believed to be due to the individual and the sentence was not switched for a new one. The recordings were then recorded onto a portable Tascam DA-P1 digital audiotape recorder from the computer, for the perception listening task.

For the production task, each of the utterances was printed on a 5x8 inch index card using size 24 New Roman and black ink. On the bottom right corner of each index card the intended intonation, emotional (happy vs. sad) or non-emotional (statement vs. question), was printed in size 18 New Roman in black ink.

The full list of stimuli used in both the perception and production tasks, is presented in the Appendix B.

Design and Data Analysis

Production

The production component of the experiment contained two independent variables, the experimental group (EG) and the healthy controls (HC). The dependent variables were pitch range and duration.

Pitch range. The participants' productions were recorded and analyzed to determine pitch range, the difference between the initial vocalic nucleus and the nuclear tone. These two measures are found within the F_0 contour of an utterance (Balog et al., 2007; Snow, 2000). The F_0 contour was measured at two main points, the vocalic nucleus and the nuclear tone. The vocalic nucleus is identifiable in an utterance's contour; it appears as the initial peak or valley within an utterance. The nuclear tone is the last and most apparent accent point in a multi-syllabic utterance, in other words it is the final measureable F_0 within an utterance (Snow, 2006). The vocalic nucleus is the point where the voicing begins; it is the point also referred to as the phrasal accent, the initial peak or valley perceived in the F_0 contour (Seddoh, 2000; Snow, 2000).

Identifying these point major points within an utterance allows for calculation of accent range and directional difference. There are F_0 contour patterns, which correspond to how intonation patterns in non-emotional and emotional utterances are perceived by listeners. For non-emotional utterances, statements and questions, and emotional utterances, happy and sad, there are falling and rising pitch patterns which can be measured by determining the vocalic nucleus and the nuclear tone. There are specific measures that are expected for non-emotional and emotional F_0 contours. For non-emotional speech, statements typically present with a nuclear tone that is lower than the vocalic nucleus, this appears as a falling tone pattern. Comparatively, the nuclear tone is higher than the vocalic nucleus in questions. The examples, 'John gave you the key.' and 'John gave you the key?' shown in Figure 1, present the expected rising and falling patterns of statements and questions.

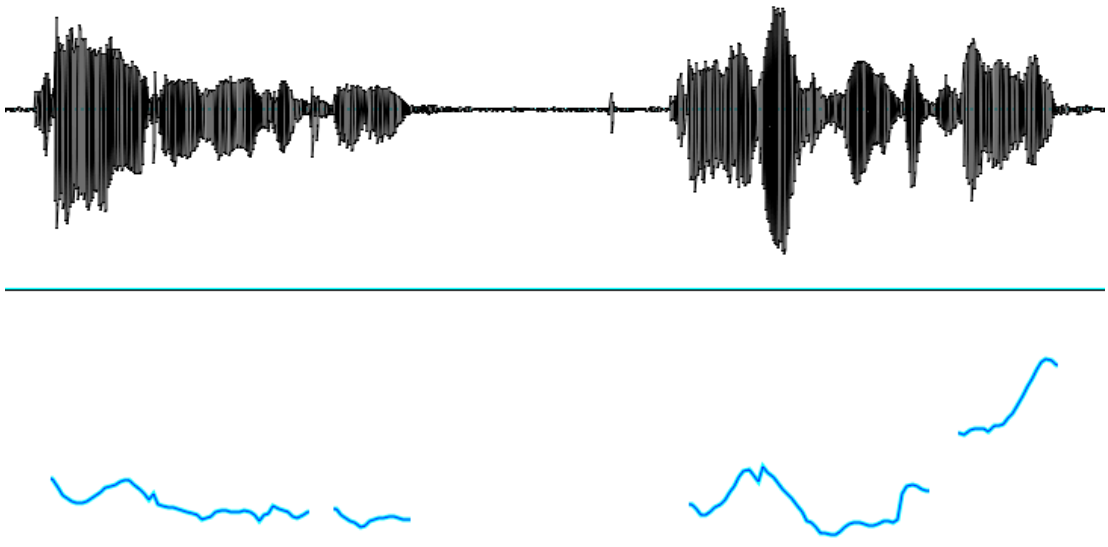

Figure 1: The waveform and pitch (F_0) contour. A) 'John gave you the key.' and B) 'John gave you the key?'

Similarly for emotional speech, sad utterances typically present with a nuclear tone that is lower than the vocalic nucleus, however the falling tone in this case is a low-falling tone (Cruttenden, 1979). This means that the nuclear tone for sad utterances should be lower than the vocalic nucleus but not by as great a difference as is present with the falling tone in statements. Happy utterances present with a nuclear tone that rises, similar to that of the question, but this rising tone is low rising tone, the change is not as significant as it is with the non-emotional intonation (Cruttenden, 1979; Crystal, 1986). The examples, 'Mark saw his stereo.' and 'the bouquet is red.' presented in Figure 2 shows the expected intonation pattern for sad and happy utterances respectively.

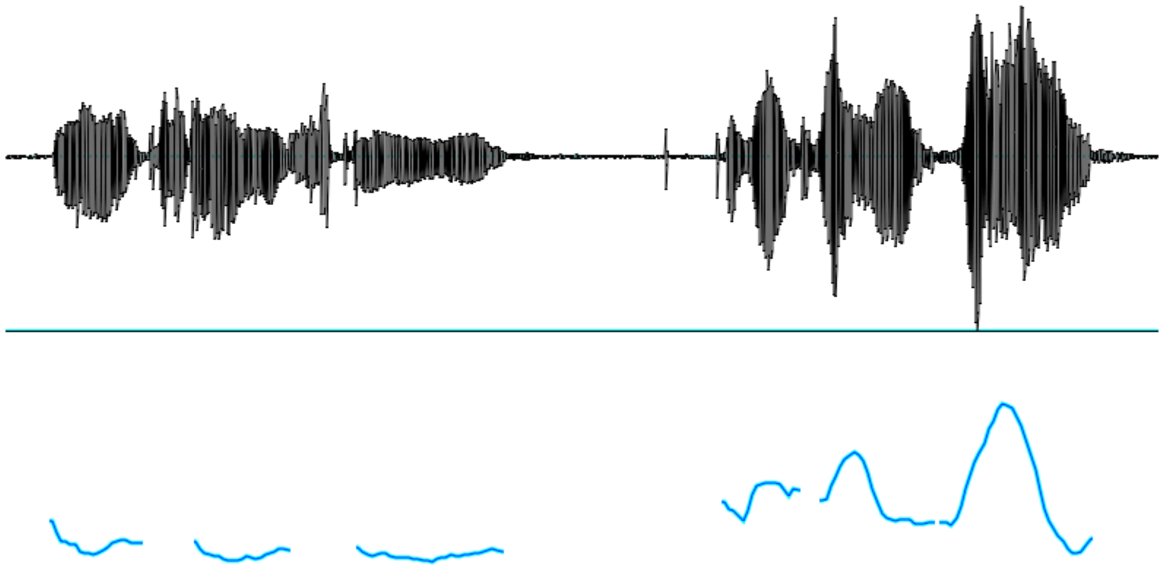

Figure 2: The waveform and pitch (F_0) contour. A) 'Mark saw his stereo.' and B) 'The bouquet is red.'

The pitch range was broken down into four variables, happy negative, happy positive, sad positive, sad negative, for the emotional and four variables, statement negative, statement positive, question negative, question positive, for the non-emotional tasks. The pitch range was measured this way to account for the direction of the F_0 contour.

Duration. The duration of each utterance was measured and averages calculated for each group. The duration of an utterance can help to provide information about intonation. Snow (2000) indicates that when different emotions are portrayed in speech the duration of statements differs. For example, happy utterances tend to be shorter than sad utterances. The duration was also measured to determine if there a difference between the EG and HCs for non-emotional and emotional speech. The duration was measured by initial sound until the final utterance boundary. Average duration was calculated across four measures for each participant, duration happy utterances, duration sad utterances, duration statements, and duration questions.

Analysis. The data were analyzed separately for the non-emotional and emotional production tasks. The pitch range and duration were all plotted to identify if there were any pronounced differences seen in the data. One-way analysis of variance (ANOVA) was calculated for each dependent variable to determine significance.

Perception

There were two independent variables the EG and the HC, the dependent variables of the perception task were the responses. The responses were correct, incorrect, or unsure; these were tallied and averages were found for each participant. The average data were then averaged and analyzed using a Mann Whitney U Test of independent samples, to determine if a response was chosen more often than by chance. This was done to determine if there was an overall response/perception difference between the EG and HCs. The data were then analyzed using a Mann Whitney U Test, to determine if there were specific group differences for each sentence type.

Procedure

Production task

Participants were told that the purpose of the production task was to determine if the problems that patients with Parkinson's disease present with are solely motor based or if there are higher-level difficulties present.

The stimuli, 100 utterances, were all presented during one session. The utterances were each presented to participants on a 5x8 index card. To ensure that the productions were as natural as possible, participants were instructed to read the sentences silently to themselves prior to saying them, rather than simply reading them out loud for recording. The production task was completed prior to the perception task to eliminate any influence on participant productions.

Recording occurred in a quiet setting in a single session using an AKG C 420 III PP microphone. The microphone was attached to a headband and was held approximately 10 centimeters from participants' lips. The microphone signal was passed to a Tascam DA-PI digital audio tape recorder and recorded onto a Sony DAT PDP-125 audiotape. The recordings were then transferred onto a computer using the Praat software, version 1.0. The utterances were analyzed using the Praat software, version 1.0.

Perception Task

Participants were told that the purpose of the listening task was to determine if patients with Parkinson's disease have difficulty with the perception of intonation in non-emotional and emotional speech. Participants were encouraged to ask questions regarding the task.

Response sheets were provided to each participant. Participants were provided with three options for each sentence in the two tasks. The options provided for the non-emotional sentence stimuli were as follows: Statement, Question, and Unsure. The options for the emotional sentence stimuli were as follows: Happy, Sad, and Unsure.

Participants were asked to indicate the speaker's intended meaning by circling their response.

The stimuli were presented to participants auditorily from the portable DA-PI recorder through loudspeakers, during one session in a quiet setting. The order of presentation was random. All participants heard the sentences conveying emotional speech first, followed by the sentences conveying non-emotional speech.

CHAPTER IV

RESULTS

Production

Emotional Task Results

Pitch range. The pitch range was divided into four variables, happy positive, happy negative, sad positive, sad negative; this was done to provide information regarding the direction of the pitch change. Table 1 provides descriptive information; mean and standard deviation, of the pitch range of the dependent variables that were measured in the emotional production task. The variables are separated for positive and negative, which describes whether the utterance pitch increased or decreased from beginning to end

Table 1. Descriptive information, mean and standard deviation for the dependent emotional variables.

Group	Variable	Mean	Standard Deviation
* EG	Range Happy Positive	23.49	20.68
* HC	Range Happy Positive	50.45	15.98
EG	Range Happy Negative	44.12	16.09
HC	Range Happy Negative	38.05	17.65
EG	Range Sad Positive	9.17	15.93
HC	Range Sad Positive	14.17	36.17
EG	Range Sad Negative	51.56	16.67
HC	Range Sad Negative	44.09	17.65

Significant difference was found for the happy utterance that positively increased.

The mean values for the positive pitch range of happy utterances, appear to be considerably different, where as the means for the other dependent variables appear similar. Figure 3, a box plot of the positive pitch range for the happy utterances produced by the participants, shows that the data for the two independent variables, EG and HC, differ significantly. Comparatively, the box plots for the three other dependent measures, as seen in Figures 4 – 6, do not show a great deal of variability in the data.

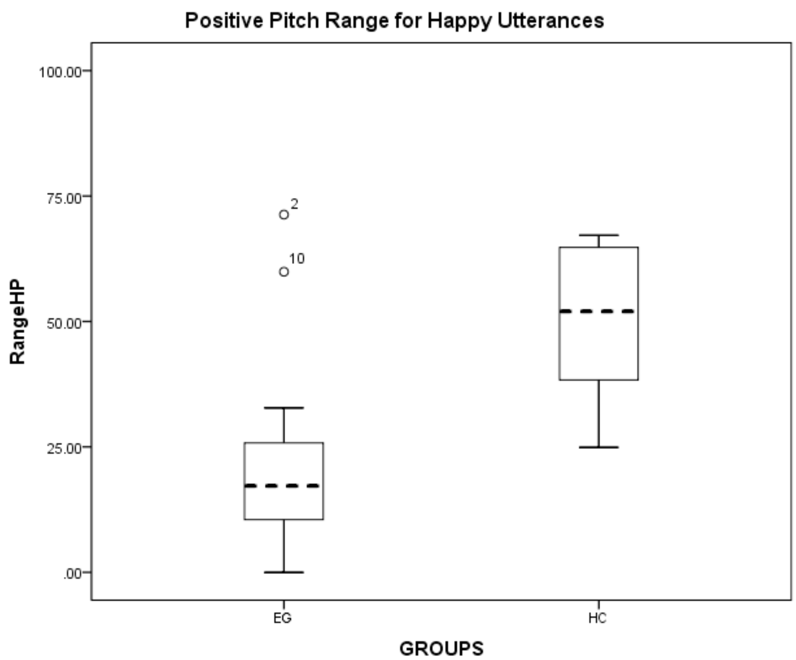

Figure 3: Box plot comparison of the positive pitch range for the happy utterances between EG and HC .

Comparatively, the box plots for the three other dependent measures, as seen in Figures 4 – 6, do not show a great deal of variability in the data. The figures provide evidence to indicate that there is not a large difference between the production of intonation conveying sad emotional information between the EG and HC. Figure 4, the negative pitch range for the happy utterances shows that the means do not differ greatly.

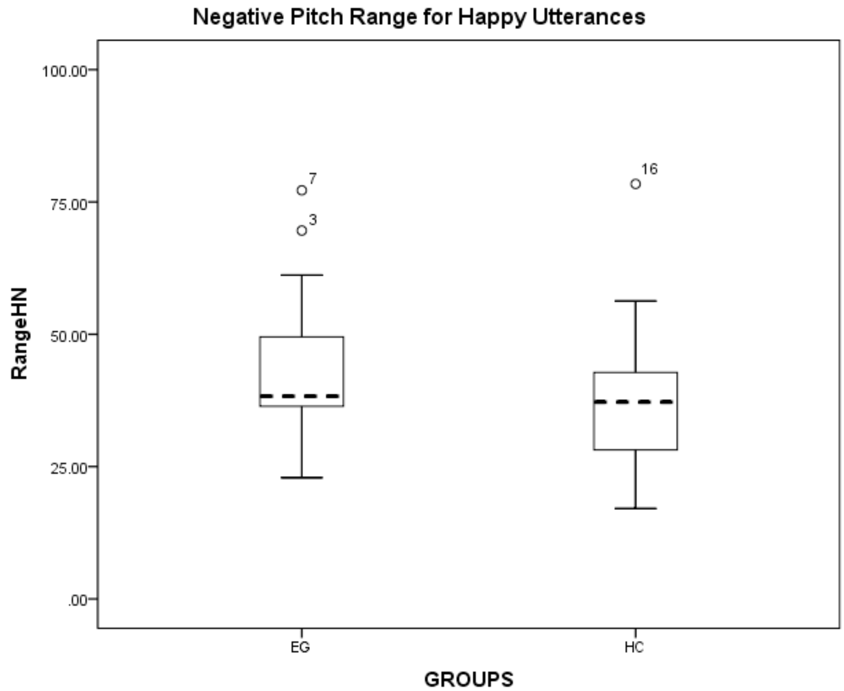

Figure 4: Box plot comparison of the negative pitch range for happy utterances between the EG and HC.

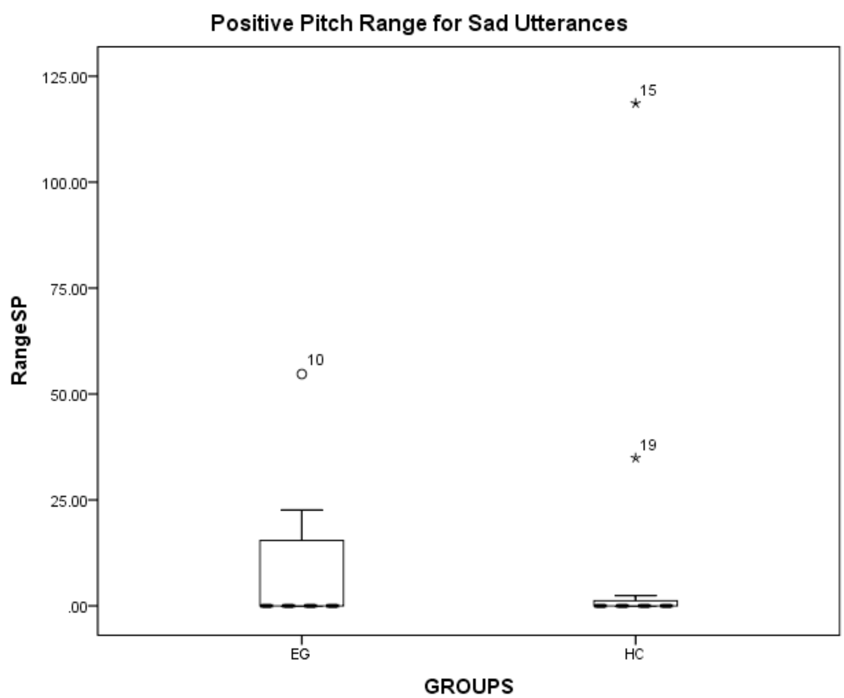

Figure 5: Box plot comparison of the positive pitch range for sad utterances between the EG and HC.

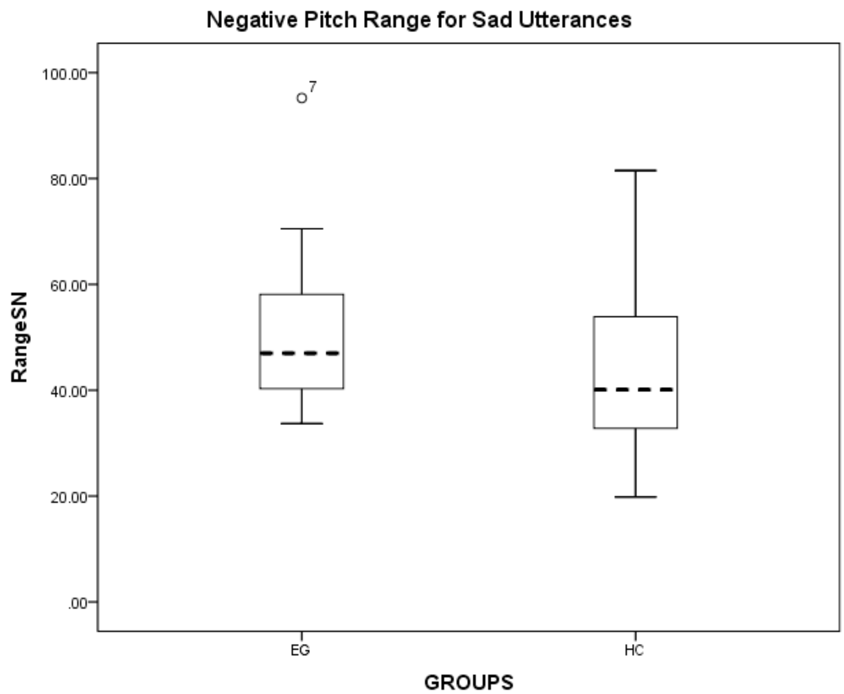

Figure 6: Box plot comparison of the positive pitch range for sad utterances between the EG and HC.

Duration. The duration (in seconds) for the happy and sad utterances was computed and compared between groups. Table 2, provides descriptive information mean and standard deviation, for the duration of happy and sad utterances.

Table 2. Descriptive statistical information regarding duration of happy and sad utterances.

Group	Variable	Mean	Standard Deviation
EG	Duration of Happy	1.47	0.16
HC	Duration of Happy	1.51	0.22
EG	Duration of Sad	1.60	0.20
HC	Duration of Sad	1.75	0.34

Figures 7 and 8, display the variation in time to produce the utterances between the two groups. The box plots show that though the range of responses may differ the means for the two groups are approximately the same.

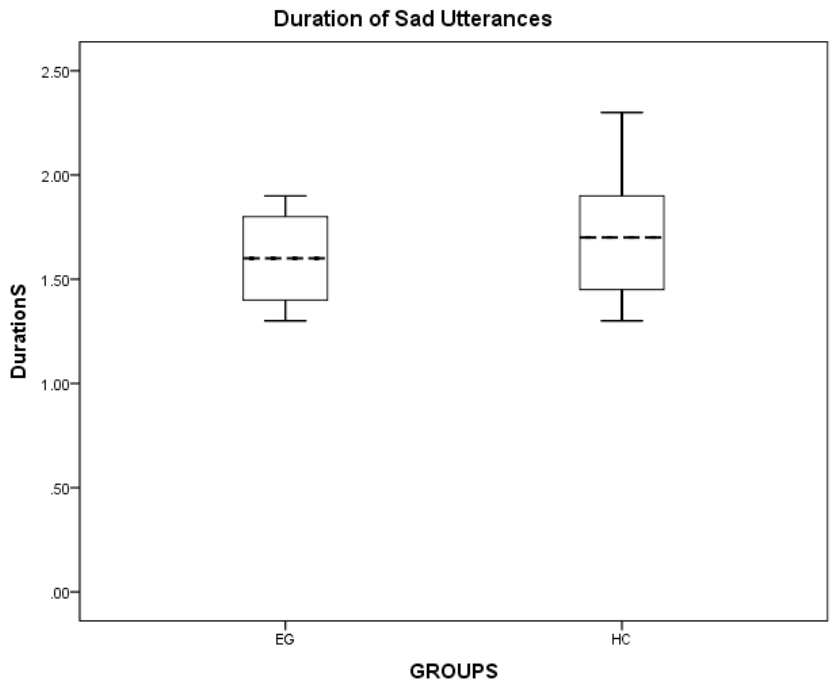

Figure 7: Box plot comparison of the duration for sad utterances between the EG and HC.

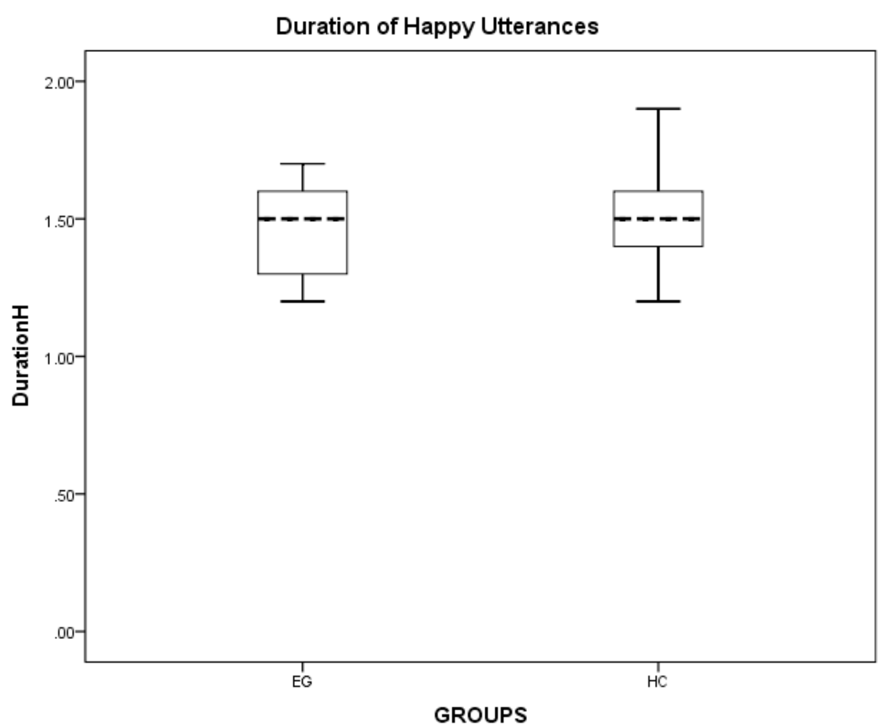

Figure 8: Box plot comparison of the duration for happy utterances between the EG and HC.

Inferential statistics. Though the box plots provided evidence to suggest that there was not a great deal of difference between the two groups of participants across all six dependent measures, one-way analysis of variance (ANOVA), were completed for each pitch range and duration measure. Levene's list of homogeneity of variances was found to be not significant and therefore quality of variances was assumed. The one-way ANOVAS for each measure presented a significant difference between the EG and HC for positive pitch range of happy utterances; Range HP $F_{(1,23)} = 12.4$, $p = .002$. As multiple ANOVAs were conducted, the alpha of 0.05 was adjusted using a Bonferroni correction to .0083. The other dependent variables presented with not significant results. Range HN $F_{(1,23)} = .776$, $p = .388$; Range SP $F_{(1,23)} = .204$, $p = .656$; Range SN $F_{(1,23)} = 1.134$, $p = .298$. DurationH $F_{(1,23)} = .261$, $p = .614$; DurationS $F_{(1,23)} = 1.878$, $p = .184$. The duration variables presented similar findings to all but one of the pitch range variables, that there was no significant difference between groups.

Non-emotional Task Results

Pitch range. The pitch was divided into four variables: statement positive, statement negative, question positive, and question negative. This was again done to provide information regarding the direction of the pitch range. Table 3 provides descriptive statistical information regarding the variables that were measured. The data are marked for positive and negative, which indicates the direction of change from the beginning of the utterance to the end of the utterance. The information presented in the table shows that there is greatest difference between the means for the RangeQP, positive pitch range for questions. The table also shows that for the negative pitch range of statements, the two groups had nearly identical means. The dependent variables were plotted into box plots to provide further information regarding possible group difference. The box plots, Figures 9 -12, present with similar data identified in the table.

Table 3. Descriptive information, mean and standard deviation for the dependent non-emotional variables

Group	Variable	Mean	Standard Deviation
* EG	Range Question Positive	102.05	51.18
* HC	Range Question Positive	147.62	47.23
EG	Range Question Negative	27.23	38.59
HC	Range Question Negative	18.48	38.56
EG	Range Statement Positive	36.98	63.55
HC	Range Statement Positive	27.53	47.61
EG	Range Statement Negative	58.42	19.99
HC	Range Statement Negative	58.68	26.96

Significant difference was found for the questions that positively increased.

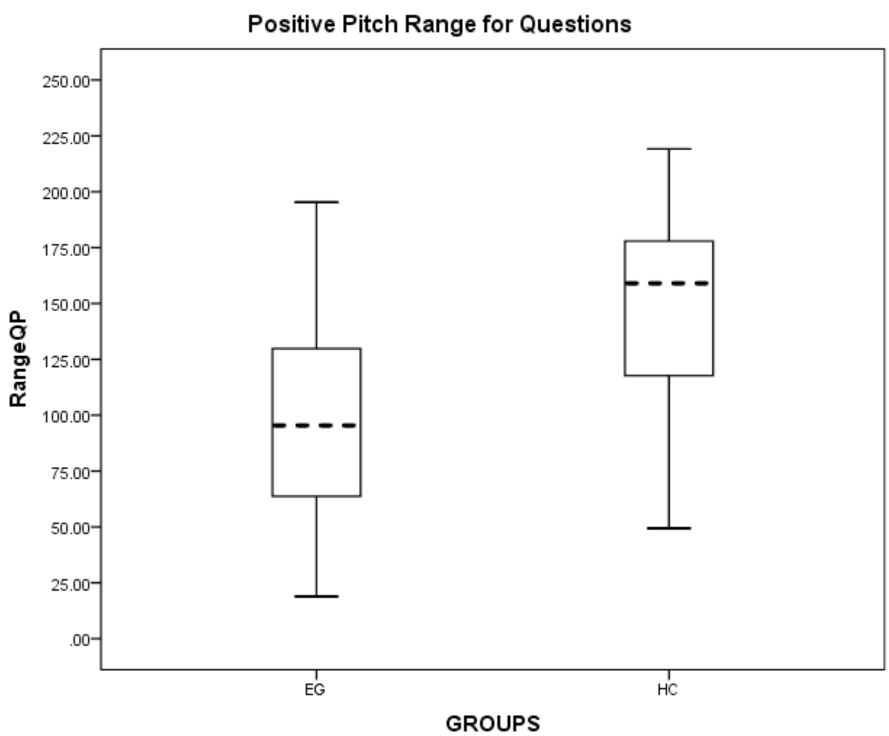

Figure 9: Box plot comparison of the positive pitch range for questions between the EG and HC.

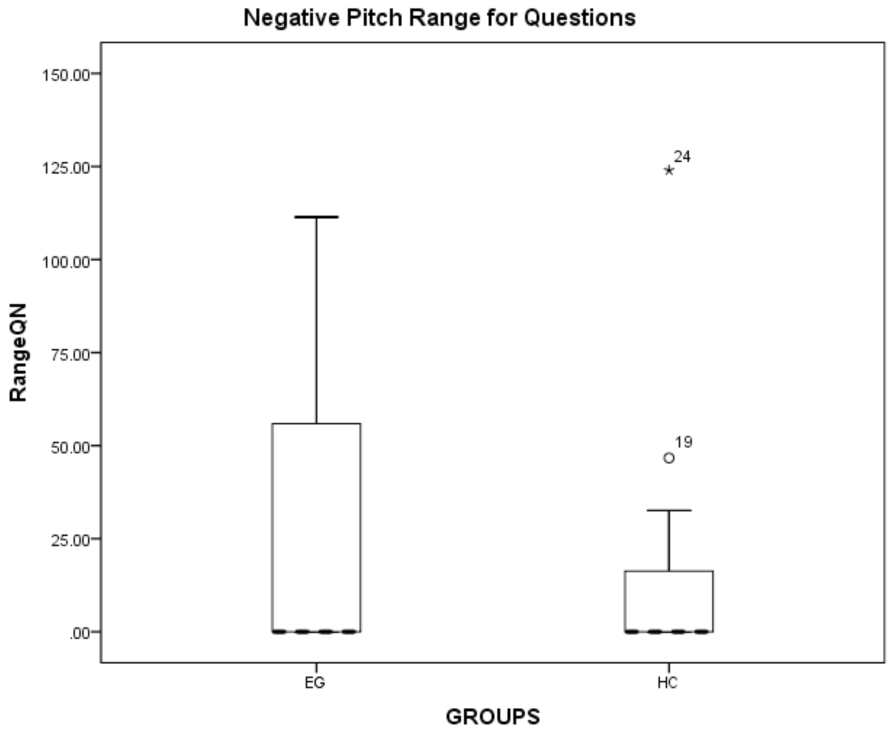

Figure 10: Box plot comparison of the negative pitch range for questions between the EG and HC.

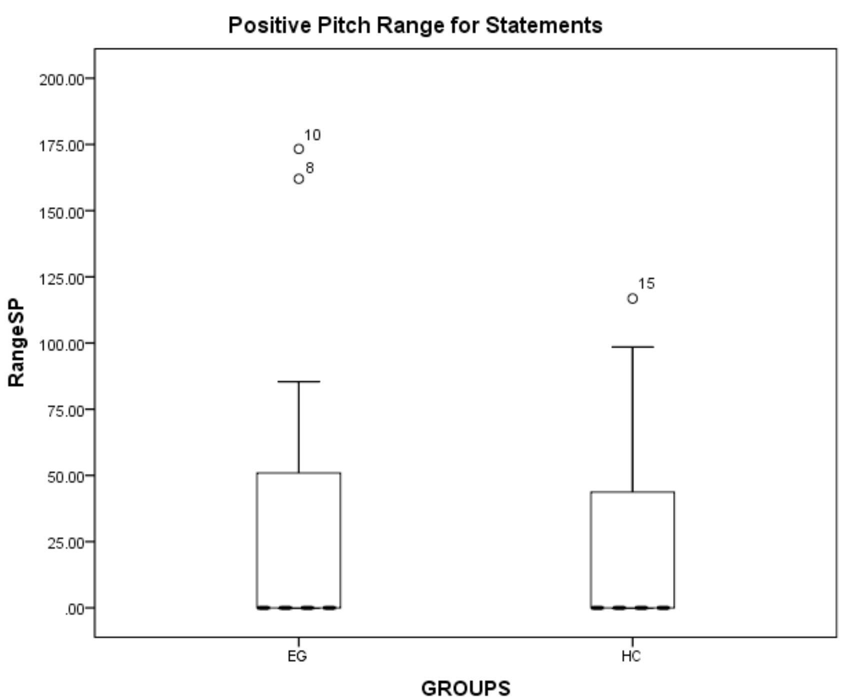

Figure 11: Box plot comparison of the negative pitch range for statements between the EG and HC.

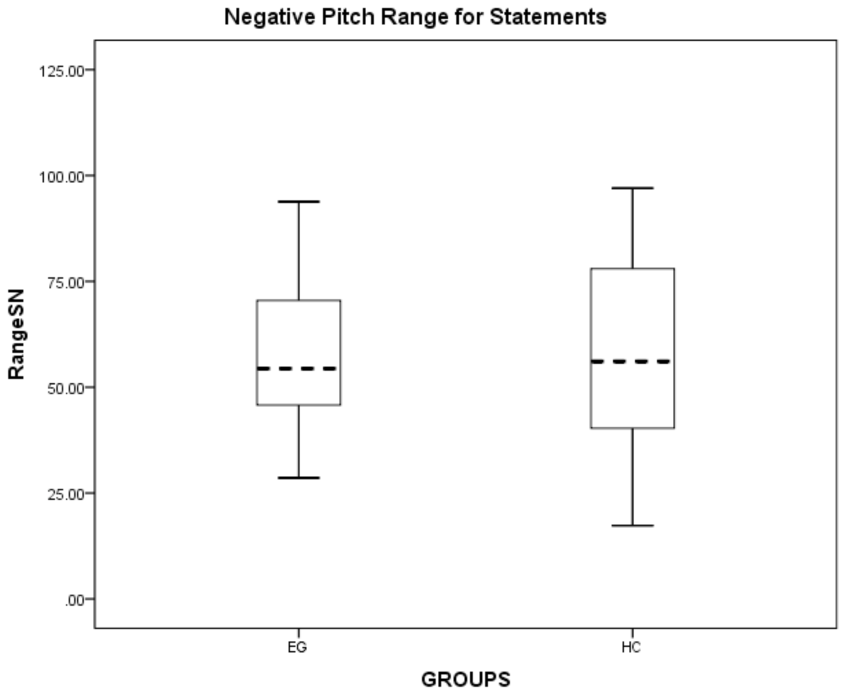

Figure 12: Box plot comparison of the negative pitch range for statements between the EG and HC.

The box plots provide a clear image of the between group differences across the measured pitch range, dependent variables. Like the table, the figures show that the two groups were similar across majority of measures, and that it was only the positive pitch range for questions that presented a significant difference.

Duration. Table 4, provides the descriptive statistical information, mean and standard deviation for the between group durations that were measured.

Table 4: Descriptive statistical information regarding duration of happy and sad utterances.

Group	**Variable**	**Mean**	**Standard Deviation**
EG	Duration of Questions	1.47	0.16
HC	Duration of Questions	1.51	0.22
EG	Duration of Statements	1.60	0.20
HC	Duration of Statements	1.75	0.34

The table shows that there was not a great deal of difference between the two groups. Figures 13 – 14, present the duration variable measures in box plots, which show that the two groups did not differ significantly for duration of utterances.

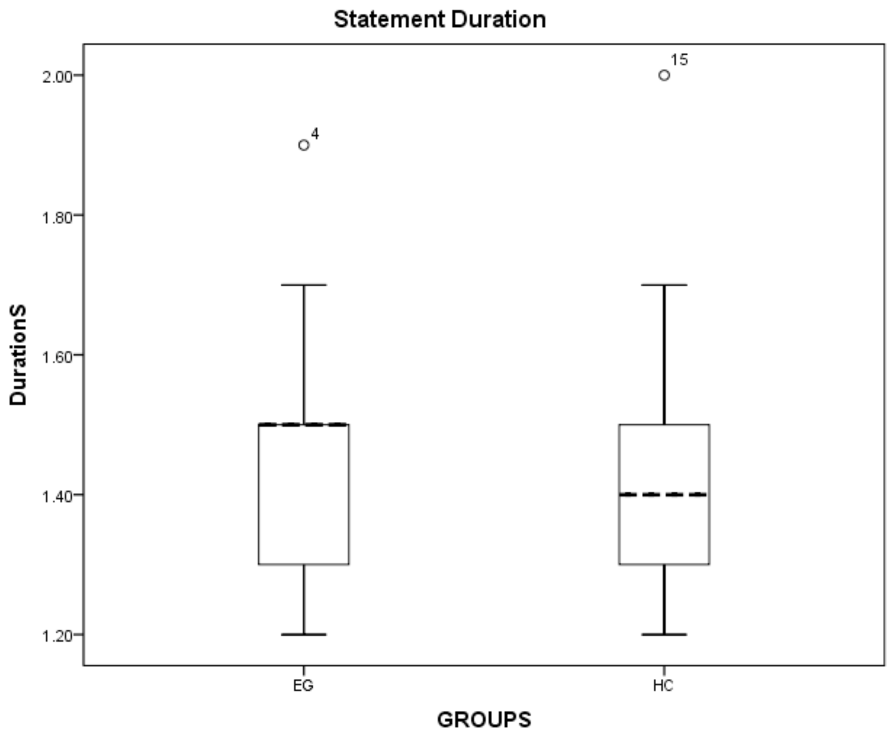

Figure 13: Box plot comparison of the duration of statements between the EG and HC.

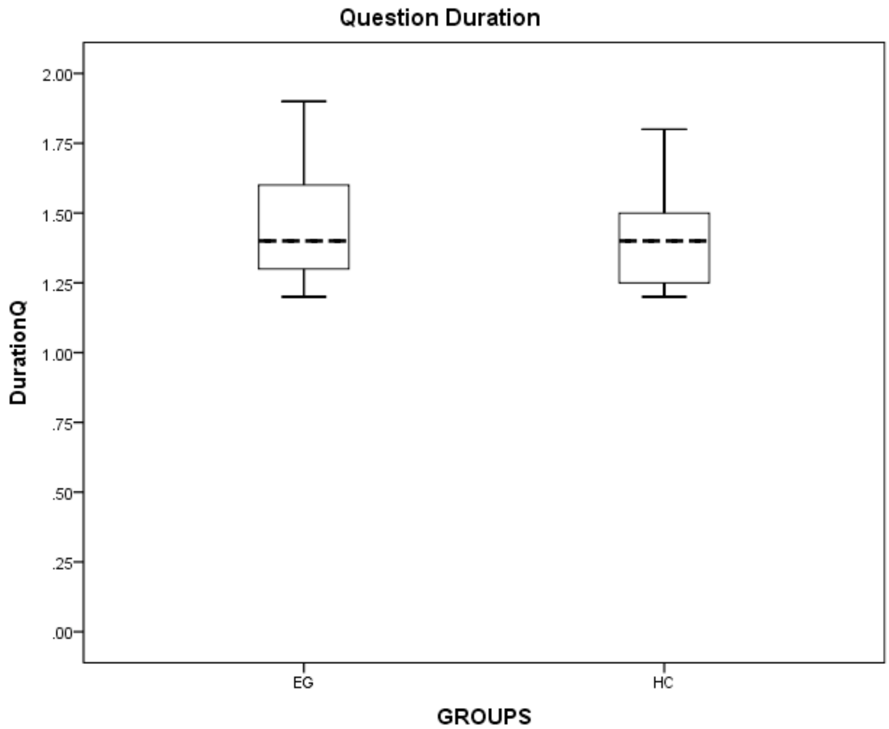

Figure 14: Box plot comparison of the duration of questions between the EG and HC.

Inferential statistics. Statistical analysis was conducted to determine if any significant difference could be identified. One-way ANOVA were completed for each of the non-emotional dependent variables. Quality of variances was assumed as Levene's list of homogeneity of variances was found to be not significant. The one-way ANOVAS for each measure presented a significant difference between the EG and HC for positive pitch range of questions; Range QP $F_{(1,23)} = 5.07$, $p = .035$. The following results were found for the other variables, however, no significance was identified; the negative pitch range of questions, RangeQN $F_{(1,23)} = .307$, $p = .585$. The positive and negative pitch ranges for statements, RangeSP $F_{(1, 23)} = .165$, $p = .689$ and RangeSN $F_{(1,23)} = .001$, $p = .979$, show that the data is not significant for differences between the two groups. The duration variables, DurationQ $F_{(1,23)} = .533$, $p = .473$ and DurationS $F_{(1,23)} = .079$, $p = .782$, were also not significant.

These results indicate that the deficit of producing intonation in non-emotional and emotional contexts is likely due to motor-based deficits.

Perception

The perceptual data for the non-emotional and emotional tasks were analyzed as averages. Responses were tallied for each participant and then tallies were averaged for the groups. A non-parametric analysis of independent samples was conducted. The Mann Whitney U test was done to analyze the distribution of the data and to compare group median values; both analyses were done to determine if responses were significant beyond chance. For the perceptual data the analysis looked at the medians for each dependent variable, Correct Emotional, Incorrect Emotional, Unsure Emotional, Correct Non-emotional, Incorrect Non-emotional, and Unsure Non-emotional and compared them between the two participant groups. The results found a significant difference between the two groups for the Incorrect Emotional variable, with a $p = .047$. It should be noted however that this significance is likely due to two outliers in the data. If the outliers were removed it is unlikely that the data would prove significant. Figures 15, displays the box plot for the emotional data, which clearly shows that the outlier data has a great effect on the significant results identified for the Incorrect Emotional variable. Figure 16, presents a bar graph of the non-emotional data for the perception task, the graph shows that there is no difference between the two groups.

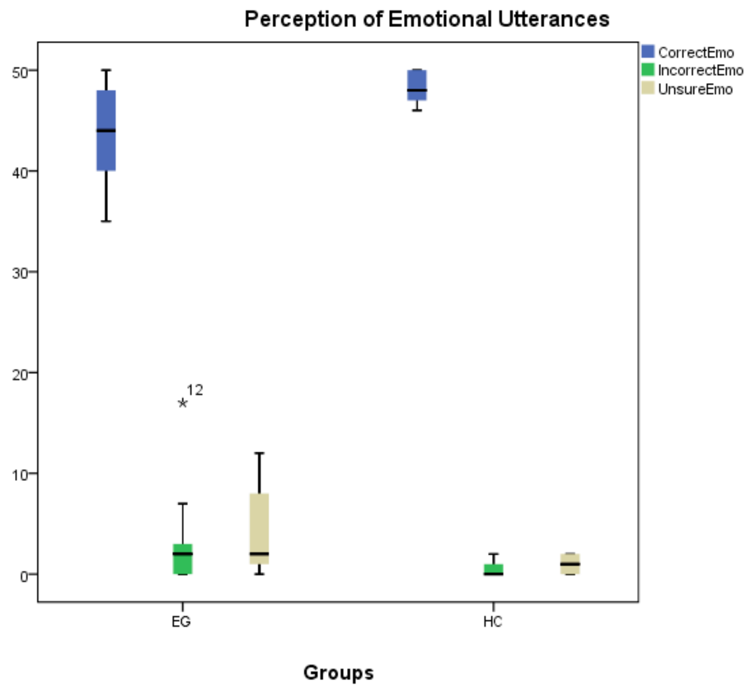

Figure 15: Box plot presenting the responses of the groups for the emotional perception task

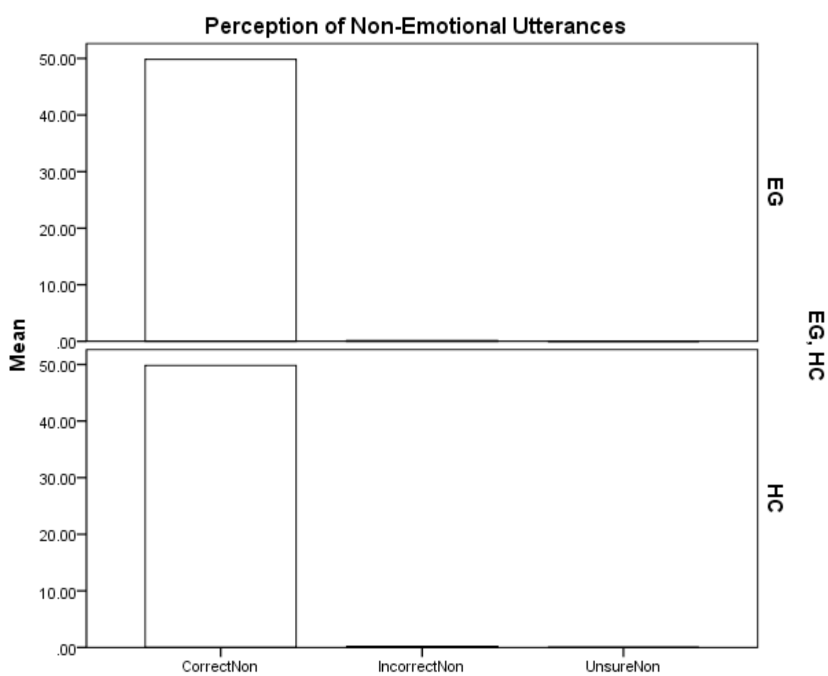

Figure 16: Bar graph presenting the responses of the groups for the non-emotional perception task

CHAPTER V

DISCUSSION

Significant differences were identified for two of the dependent variables of the production tasks, the positive pitch patterns of questions and happy utterances. The final F_0 measure should rise for these types of utterances. Pitch raising is more difficult than pitch lowering as it requires greater muscle and vocal cord coordination. These results indicate that the deficits of producing intonation for non-emotional and emotional speech may in fact be due to motor-based impairments, which is in accordance with previous research findings. Unlike previous studies the current study looked at production and perception of intonation in non-emotional and emotional speech. The significant difference identified in the emotional perceptual data, was likely due to two outliers within the data pool. Due to the minimal difference noted in the emotional perceptual data and lack of significance for the perception of intonation in non-emotional speech, it can be concluded that the nature of the deficits are not due to higher-level processing. These findings support the previous research on the production of intonation in non-emotional and emotional speech, which state that the deficits are due to phonetic level and motor planning deficits associated with Parkinson's disease (Cheang et al., 2007; Mennen et al., 2008; Harel et al., 2004; Pell et al., 2006).

The significance found for the emotional perceptual data, which was likely due to two outliers does not support previous research findings. Studies on the perception of intonation in emotional contexts have presented evidence that individuals with Parkinson's disease perform significantly worse than healthy controls (Benke et al., 1998; Breitenstein et al., 1998; Breitenstein et al., 2001; Pell et al., 2003). Though significance was found for one of the variables, the significance can be explained by outlier data. The lack of significance for the non-emotional perceptual data supports previous research conducted by Pell (2006) who found that individuals with Parkinson's disease performed equally to healthy controls, when asked to discriminate intonation of non-emotional speech. The lack of significant differences found in the perceptual data indicates that higher-level processing for these patients with Parkinson's disease is intact.

The current study did not identify possible gender differences for pitch range. Males and females differ in their vocal range and this may have affected the current results. Also, the participants did not have uniform deficits; meaning that different results may have been found had the experimental group been individuals whose deficits were all lateralized to one side of the body, or all having bilateral deficits. Further research may be done to determine if individuals of the same gender, who all have lateralized left sided, right sided or bilateral deficits perform differently on these tasks than the current participant group. Another issue with the current study was that the majority of the participants were taking their medication to treat their Parkinson's disease during the testing. The medications control their symptoms and this may have affected the results of the tasks, especially the production tasks. Also, a number of the participants were taking anxiety/depression medication, which may have hindered their performance as well. It may also have been beneficial to study different groups of individuals with Parkinson's disease who were matched for age, gender, motor impairments, and length of disease;

then compared them with each other and with healthy controls. Another possibility for further research would be to determine processing abilities of intonation in conversational speech. Simple utterances were used for the study, but it may be beneficial to identify possible deficits associated with processing intonation in non-emotional and emotional conversational speech.

The current study provided information regarding intonation processing in individuals with Parkinson's disease. The basic findings of the current study were:

1. Difficulty producing intonation of emotional and non-emotional speech is likely due to motor-based impairments. As only significant differences were identified between groups when pitch raising was a factor
2. Perceptual deficits in emotional speech, which were identified, were likely due to outlier data.
3. No difference was identified between the experimental group and the healthy controls for the perception of statements and questions.
4. There was no significant difference identified for the duration for utterances between the two groups.

APPENDICES

APPENDIX A

RESPONSE SHEETS

Non-emotional Stimuli Response Sheet

1. Statement	Question	Unsure
2. Statement	Question	Unsure
3. Statement	Question	Unsure
4. Statement	Question	Unsure
5. Statement	Question	Unsure
6. Statement	Question	Unsure
7. Statement	Question	Unsure
8. Statement	Question	Unsure
9. Statement	Question	Unsure
10. Statement	Question	Unsure
11. Statement	Question	Unsure
12. Statement	Question	Unsure
13. Statement	Question	Unsure
14. Statement	Question	Unsure
15. Statement	Question	Unsure
16. Statement	Question	Unsure

17. Statement	**Question**	**Unsure**
18. Statement	**Question**	**Unsure**
19. Statement	**Question**	**Unsure**
20. Statement	**Question**	**Unsure**
21. Statement	**Question**	**Unsure**
22. Statement	**Question**	**Unsure**
23. Statement	**Question**	**Unsure**
24. Statement	**Question**	**Unsure**
25. Statement	**Question**	**Unsure**
26. Statement	**Question**	**Unsure**
27. Statement	**Question**	**Unsure**
28. Statement	**Question**	**Unsure**
29. Statement	**Question**	**Unsure**
30. Statement	**Question**	**Unsure**
31. Statement	**Question**	**Unsure**
32. Statement	**Question**	**Unsure**
33. Statement	**Question**	**Unsure**
34. Statement	**Question**	**Unsure**
35. Statement	**Question**	**Unsure**

36. Statement	Question	Unsure
37. Statement	Question	Unsure
38. Statement	Question	Unsure
39. Statement	Question	Unsure
40. Statement	Question	Unsure
41. Statement	Question	Unsure
42. Statement	Question	Unsure
43. Statement	Question	Unsure
44. Statement	Question	Unsure
45. Statement	Question	Unsure
46. Statement	Question	Unsure
47. Statement	Question	Unsure
48. Statement	Question	Unsure
49. Statement	Question	Unsure
50. Statement	Question	Unsure

Emotional Stimuli Response Sheet

1. Happy	Sad	Unsure
2. Happy	Sad	Unsure

3. Happy	Sad	Unsure
4. Happy	Sad	Unsure
5. Happy	Sad	Unsure
6. Happy	Sad	Unsure
7. Happy	Sad	Unsure
8. Happy	Sad	Unsure
9. Happy	Sad	Unsure
10. Happy	Sad	Unsure
11. Happy	Sad	Unsure
12. Happy	Sad	Unsure
13. Happy	Sad	Unsure
14. Happy	Sad	Unsure
15. Happy	Sad	Unsure
16. Happy	Sad	Unsure
17. Happy	Sad	Unsure
18. Happy	Sad	Unsure
19. Happy	Sad	Unsure
20. Happy	Sad	Unsure
21. Happy	Sad	Unsure

22. **Happy**	**Sad**	**Unsure**
23. **Happy**	**Sad**	**Unsure**
24. **Happy**	**Sad**	**Unsure**
25. **Happy**	**Sad**	**Unsure**
26. **Happy**	**Sad**	**Unsure**
27. **Happy**	**Sad**	**Unsure**
28. **Happy**	**Sad**	**Unsure**
29. **Happy**	**Sad**	**Unsure**
30. **Happy**	**Sad**	**Unsure**
31. **Happy**	**Sad**	**Unsure**
32. **Happy**	**Sad**	**Unsure**
33. **Happy**	**Sad**	**Unsure**
34. **Happy**	**Sad**	**Unsure**
35. **Happy**	**Sad**	**Unsure**
36. **Happy**	**Sad**	**Unsure**
37. **Happy**	**Sad**	**Unsure**
38. **Happy**	**Sad**	**Unsure**
39. **Happy**	**Sad**	**Unsure**
40. **Happy**	**Sad**	**Unsure**

41. Happy	Sad	Unsure
42. Happy	Sad	Unsure
43. Happy	Sad	Unsure
44. Happy	Sad	Unsure
45. Happy	Sad	Unsure
46. Happy	Sad	Unsure
47. Happy	Sad	Unsure
48. Happy	Sad	Unsure
49. Happy	Sad	Unsure
50. Happy	Sad	Unsure

APPENDIX B

STIMULI

Emotional Stimuli

Example 1:

Dora saw the lady → happy meaning

Example two:

Henry was at the hockey game → sad meaning

1. Sarah stopped by after work. (Sad)
2. The mail came in at 3pm. (Happy)
3. Wayne went to work after lunch. (Happy)
4. The governor is here. (Happy)
5. Mom had two jobs. (Sad)
6. Sally is in the room. (Sad)
7. John saw the list. (Happy)
8. My wife was at the meeting. (Happy)
9. My dad is in London. (Happy)
10. The door was open. (Sad)
11. John was in his uniform. (Sad)
12. Laura left the key. (Happy)
13. She found a card in her bag. (Happy)
14. The lady saw her children. (Sad)
15. Ben was in town last week. (Sad)
16. Harley saw the list last week. (Happy)
17. Daniel has a book now. (Happy)
18. Joe slept in my house. (Sad)
19. There is a cat in the room. (Sad)
20. The envelope is on the table. (Happy)
21. Sally wrote down the address. (Happy)
22. Amy was at home. (Sad)
23. The man is three years older. (Sad)
24. Sam opened the box. (Happy)
25. The nurse walked up to John. (Happy)
26. The lady left the room. (Sad)
27. Andrea read the book. (Happy)
28. Tyler walks to school. (Sad)
29. The teacher gave out the exams. (Happy)
30. Mark saw his stereo. (Sad)
31. Lesley called her dad. (Sad)
32. Daniel saw the movie. (Happy)

33. Mike was driving the car. (Sad)
34. He got a new computer. (Happy)
35. Laurie went in after I left. (Happy)
36. My dad lived in Cleveland. (Sad)
37. I got the picture frame. (Sad)
38. Matt narrated the story. (Sad)
39. Laura was in London. (Happy)
40. Mom was at the soccer game. (Happy)
41. I had a call from the school. (Happy)
42. The bouquet is red. (Happy)
43. Grandpa sat on the chair. (Sad)
44. The bus arrives at noon. (Happy)
45. The girl saw her doll. (Sad)
46. Emma saw the crowd. (Happy)
47. David saw the dog. (Sad)
48. Dad put the chair in Ali's room. (Sad)
49. Her daughter was at home. (Sad)
50. He gave me the gloves. (Sad)

Non-Emotional Stimuli

Example 1:

He lost the money? → question

Example 2:

Her ex-husband showed up. → statement

1. Sally was admitted.
2. She was not ready to apologize?
3. He admitted the crime?
4. Mom wanted a cup of coffee.
5. She tried to save the boy?
6. The bag is blue.
7. The book is with me.
8. He came to see me?
9. Henry is the love of her life?
10. Maggie is in town.
11. Amy graduated?
12. Mary ate the pie?
13. Amy graduated.
14. She did not visit him?
15. She saw the dress.
16. Cheryl is in my house.
17. He organized a party for his friends?
18. You like donuts.

19. John gave you the key?
20. You have been in bed all day.
21. Michelle is a teacher.
22. Henry is the love of her life.
23. John is in his office.
24. Mary ate the pie.
25. The bag is blue?
26. She saw the dress?
27. He admitted the crime.
28. She tried to save the boy.
29. Cheryl is in my house?
30. The teacher was in the library?
31. Maggie is in town?
32. John gave you the key.
33. John is in his office?
34. The clock is not working.
35. They got married in January.
36. You have been in bed all day?
37. He visited his family?
38. They got married in January?
39. You like donuts?
40. She did not visit him.
41. Michelle is a teacher?
42. Mom wanted a cup of coffee?
43. She was not ready to apologize.
44. He came to see me.
45. Sally was admitted?
46. He organized a party for his friends.
47. The clock is not working?
48. The book is with me?
49. The teacher was in the library.
50. He visited his family.

Please note: examples were only used in perception task as part of the instructions.

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