The Effect of Prosody on Decision Making

A Senior Thesis

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by

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Abstract

This study sought to induce mood through affective prosody and then measure whether this had a significant effect on decision making. Prosody can be defined as tone, rate, or stress patterns that occur during speech. Prosody, when used to convey emotion, is termed affective prosody. Prior research suggests that mood is a viable predictor of performance on risky decision making tasks. More specifically, positive mood has been linked with heuristic processing, which relies on emotional reasoning. Initially, individuals feel more averse to losses and more pleased with wins, leading to more advantageous decision making. Negative emotion has been linked with substantive/systematic processing; individuals tend to exhibit more disadvantageous decision making initially in an effort to determine the most favorable outcome. This study investigated whether affective prosody alone could directly induce mood and thereby alter performance on an unrelated decision making task. This study utilized the Hungry Donkey Task, which is adapted for use with both children and adults to measure risk taking. It was hypothesized that adults induced with positive affective prosody would make more favorable decisions in early trials, while those induced with negative affective prosody would make riskier decisions initially. Mood was successfully induced with affective prosody such that participants in the positive condition reported more positive self-report mood than the negative condition. Results do not support the hypothesis; rather display negative affective prosody as eliciting better decision making in both the early and later trials. This may be a result of the positive condition relying on heuristic processing, which may have led to less advantageous decisions. This study helps build a greater understanding of the effects of mood on risky decision making and lends support to the claim that affective prosody can serve as an influencing factor in others' behavior.

The Effect of Prosody on Decision Making

Prosody is an important non-verbal aspect of speech (Leitman et al., 2010); this variance in speech, such as pitch, rate, and loudness, provides extralinguistic information such as the speaker's emotional expression (Cutler, Dahan, & van Donselaar, 1997; Fernald, 1989). Prosody, when used to convey emotion, is defined as affective prosody; it is typically presented in conjunction with semantic cues (Goerlich, Schiller, Van Heuven, Aleman, & Martens, 2012). The influence affective prosodic information has on the listener is still not completely understood. The present author proposes that the meaning of the words may not be the only influencing factor on human behavior, but the prosodic aspects of speech interact to play a crucial role in influencing human behavior. The present study sought to examine the effect that affective prosody may have on the listener's mood and subsequent behavior without the aid of semantic information. Specifically, the present research aimed to investigate if emotional cues such as tone, rate, and pitch actually induce a particular mood and subsequently influence performance on an unrelated cognitive task.

The present study sought to uncover a possible relationship between affective prosody, mood, and risky decision making. The importance of this relationship could be applied to real word instances where instructions are given, and depending on the prosody of the speaker, may lead to different reactions. For example, if a doctor suggests that his/her patient undergo a procedure in a more somber tone, how might it differ from a positive tone? These emotional factors would be particularly important in instances where decision makers have no prior knowledge regarding the situation (Forgas, 1995) or are making the decision under uncertainty (Bechara & Damasio, 2005).

Prosodic cues may be subtle or quite obvious to the listener depending on the situation. For example, when an individual wishes to convey anger, they might lower their tone, slow their speech rate, and raise their volume to sound angry (Leinonen, Hiltunen, Linnankoski, & Laakso,

1997). The ability to understand emotion conveyed through speech is important to the overall communication process (Iredale, Rushby, Mcdonald, Marco, & Swift, 2013). Language has an influential effect on human actions, but much research into the effect of non-verbal aspects is still needed. Much of the previous research examines prosody in collaboration with semantic content (word meaning). However, these prosodic cues are sometimes used to express meaning that is different from the semantics of the words, as in the case of sarcasm (Cutler, et al., 1997). One cannot ignore the possible effect that affective prosody might have on human behavior without the interference or entanglement of word meaning.

Affective Prosody Comprehension

Communication is an important aspect of human interaction; it allows individuals to form meaningful relationships, share information, and express intentions in times of necessity (Fernald, 1989). Prosodic aspects of speech are useful in aiding the interpretation of emotional intent (Mitchell & Ross, 2008). When an individual expresses emotion, they may utilize distinct voice qualities, such as frequency or rate (Mitchell & Ross, 2008). Prosody has also been shown to be important with regards to language development (Fernald, 1989). Infants rely heavily on prosodic cues from parents until eventually developing more sophisticated language skills (Fernald, 1989). This early reliance on prosody underscores its importance on human development and poses questions about its significance on adult and child behavior.

Current research has begun to speculate a possible connection between affective prosody and behavior outside of the domain of language (Jaywant & Pell, 2012; Pell, Jaywant, Monetta, & Kotz, 2011). Comprehension of affective prosody has been linked with quicker response times on tasks involving identification of facial expressions, which suggests that affective prosody may be processed similarly to visual emotional cues (Jaywant & Pell, 2012). Jaywant and Pell examined how participants responded to identifying facial features after being primed with prosody recordings (nonsense sentence recorded using six different emotional tones). These

recordings permitted examination of the influence of prosody without conflict with semantic information (Jaywant & Pell, 2012). When the prosody was matched with the facial expression, it led to quicker responses and fewer errors than when the facial expression and prosody were incongruent. This research suggests that affective prosody may work in collaboration with facial expression to enable identification and comprehension of emotional intent (Jaywant & Pell, 2012). This congruency effect may link affective prosody as having an effect on comprehension of emotional content. Jaywant and Pell argue that emotional comprehension may be interpreted through a multi-modal system which implicates affective prosody comprehension as sharing processes with comprehension of facial expressions (Jaywant & Pell, 2012). This research suggests a significant role of speech prosody in terms of emotional comprehension.

Affective prosody has been shown to influence behavioral empathy in accordance with matching semantic content and facial expressions (Regenbogen et al., 2012). Regenbogen et al. tested the response to emotional stimulation through video clips featuring three forms of emotional conveyance (facial expressions, semantic content, and affective prosody). These were split into four conditions, all emotional (emotional aspects all match), then three conditions where one aspect of presentation was neutral and the other two conveyed the emotion. Regenbogen et al. found that empathetic response (self-reported/physiological measures) was affected by the presentation of the video clips featuring emotionally meaningful words, prosody, and facial expressions. More specifically, when one aspect (semantics, prosody, or facial expression) was neutral, the reported level of empathy decreased. Prosody, when presented with matched semantics and facial expressions, was found to affect participants' empathy to a measurable degree; emotionally matched prosody strengthened the level of empathy when

compared with the neutral prosody group. This could suggest that prosody may be affecting mood as well.

Neurology of Affective Prosody and Decision Making

Through the use of neuroimaging, comprehension of affective prosody has been shown to activate both the left and right hemispheres to varying degrees, specifically the inferior frontal cortex (IFC), superior temporal gyrus (STG), and the ventromedial prefrontal cortex (VMPFC) (Fruhholz & Grandjean, 2013; Iredale et al., 2013; Schirmer & Kotz, 2006). This could suggest that affective prosody is activating sections of the brain involved in numerous aspects of processing. Affective prosody has been linked with systems of the brain that are believed to be heavily involved in more than simply language processing (Morris, Scott, & Dolan, 1999). For example, affective prosody activates regions of the brain that fall within the domain of emotional processing (Schirmer & Kotz, 2006). Schirmer and Kotz hypothesize affective prosody may affect tasks involving emotion and perception (Schirmer & Kotz, 2006). They propose multi-modal processing of affective prosody. This was brought forward in the light of more recent neuroimaging, which shows a more complex activation of the cerebral cortex than previously hypothesized (Schirmer & Kotz, 2006). This more complex activation during comprehension and production of affective prosody included regions of the ventral prefrontal cortices, which have been correlated with higher order cognitive processes (Morris et al., 1999).

Prosody may also share similar mechanisms with risky decision making. The frontal lobe, more specifically the ventromedial prefrontal cortex (VMPFC), is also believed to be heavily involved in both prosodic processing (Schirmer & Kotz, 2006) and decision making (Buelow & Suhr, 2009). This overlap of activation of regions of the prefrontal cortex could suggest a possible interaction between the processing of affective prosody and decision making. This neural overlap has spurred numerous studies in an effort to pinpoint the locations of the brain

that specifically process these emotional cues. Some research has shown that comprehension of affective prosody involves an overlap of activation of the portions of the brain linked with overall sensation and perception (Schirmer & Kotz, 2006).

One of the most frequently used measures of decision making is the Iowa Gambling Task (IGT; Bechara, Damasio, Damasio, & Anderson, 1994). The IGT was originally designed to assist in the determination of prefrontal cortex damage (Bechara et al., 1994), but it has been used successfully with a variety of populations (Bechara, 2004; Buelow & Suhr, 2009; Suhr & Tsanadis, 2007). The task involves four decks are advantageous. These decks give out smaller but more frequent rewards, coupled with small and infrequent losses, which result in overall long term gains. The other two decks are disadvantageous. These decks have higher immediate rewards but are coupled with more frequent and larger losses, which result in overall losses. This rigging of the deck payout is unknown to participants. This task typically examines the proportion of advantageous versus disadvantageous selections to determine the overall score (i.e., decision making) of the participant. Participants select decks with no knowledge of advantageous and disadvantageous deck rigging, they learn which decks are advantageous over the course of the task by selecting the decks and experiencing the wins/losses (Bechara, 2004).

Individuals with damage to the orbitofrontal cortex tend to exhibit riskier decision making on the IGT than control or participants with lesions elsewhere in the brain (Bechara, 2003). A preference for disadvantageous selection commonly found among VMPFC brain damaged patients suggests that the ventral medial orbitofrontal lobe area may play a crucial role in decision making (Bechara et al., 1994), and due to the strong association of the orbitofrontal cortex with emotion, it was hypothesized that mood would also affect the decision making task (Bechara, 2003). This section of the brain is highly correlated with emotion, and studies have found that tasks involving affective prosody comprehension affect this area to a degree (Morris

et al., 1999; Schirmer & Kotz, 2006). This overlap of activation may suggest that affective prosody may alter an individual's decision making by way of the prefrontal cortex.

Emotional Processing and Decision Making

Corresponding with the overlap in neurological activation, research studies have found that mood has an effect on decision making (de Vries, Holland, & Witteman, 2008; Mohanty & Suar, 2014). Recent studies have begun to theorize mechanisms that may explain this effect on behavior. The Somatic Marker hypothesis (Bechara & Damasio, 2005) predicts that decision making under uncertainty (no prior knowledge to base decision) is influenced by physiological markers that accompany emotions, including body signals and neurotransmitter release (Bechara & Damasio, 2005). In short, decision making under uncertainty was hypothesized to be heavily influenced by these somatic markers (gut feelings). In an instance where an individual is faced with a decision and has no prior knowledge or experience, they rely on these cues to guide their decision. This is especially important within the early trials of the IGT; these decisions would be especially sensitive to these markers since the individual would have no other basis for their decision. The study which proposed this hypothesis tested deficits in decision making on brain damaged patients and found that the patients with damage to the ventromedial orbitofrontal cortex experienced more disadvantageous decisions (Bechara, 2003; Bechara & Damasio, 2005), these participants featured the physiological responses to the risk but were not cognitively aware. Suggesting that despite them receiving the markers, the damage made them unable to react to them and perceive the risk through these markers (Bechara & Damasio, 2005). This section of the frontal lobe is heavily associated with emotional processing (Schirmer & Kotz, 2006), and activation has been seen through neuroimaging during exposure to affective prosody (Morris et al., 1999). This damage was hypothesized to prevent the use of these markers as aids and was thought to cause deficits in their decision making.

The Affect Infusion Model (Forgas, 1995) provides a possible explanation as to how affect influences cognitive processing. The model hypothesizes that affective states can influence cognitive processing to differing degrees depending on circumstances such as mood or nature of the task (Forgas, 1995). More specifically, in instances where an individual is uncertain and in a positive affective state, they may be more likely to use heuristic processing. This process relies more on simplified cues. Individuals who are uncertain and in a negative affective state are more likely to enter substantive processing. This process relies on more thoughtful and analytical aspects (Forgas, 1995). The Affect Infusion Model has been used to explain the influence that affective states have on certain tasks such as the IGT (Mohanty & Suar, 2014). More specifically, research suggests that positive mood often leads to heuristic processing and negative mood relies on more systematic processing (de Vries et al., 2008). This heuristic- or emotion-based processing may lead to an initial advantage in the IGT, but eventually the systematic processing accompanying negative affect leads to better performance in the long term on the IGT (Buelow, Okdie, & Blaine, 2013). These findings suggest a deep and dynamic connection between mood and its effect on human behavior.

Some studies that have examined the effect of mood on decision making have found that negative mood led to more advantageous decision making (Chou, Lee, & Ho, 2007; Heilman, Crişan, Houser, Miclea, & Miu, 2010; Smoski et al., 2008; Yuen & Lee, 2003) while numerous other studies have found that negative state mood and induced mood led to less advantageous selections on the initial trials of the IGT (Buelow & Suhr, 2013; de Vries et al., 2008; Suhr & Tsanadis, 2007). Studies performed using the IGT have found that individuals in a positive mood (natural and induced) made more advantageous decisions than those in negative moods in the initial blocks of the IGT (de Vries et al., 2008). Further research into more long term decision

making has shown that this trend reverses, and negative mood leads to better performance in the long run (Buelow et al., 2013).

Inducing Mood and Decision Making in Current Research

Prior research into behavior and mood typically involves self-reported mood and laboratory induced mood; both have been shown to be effective (Buelow & Suhr, 2009). In order to more efficiently study the effect of mood on seemingly unrelated cognitive tasks, many researchers (de Vries et al., 2008; Mohanty & Suar, 2014) rely on inducing mood rather than self-report of current mood conditions. This allows for better control over the sample used in a study and ensures that sample sizes remain manageable (Buelow & Suhr, 2009). These mood induction procedures often rely on a wide variety of stimuli in an effort to manipulate a participant's mood; these techniques vary widely from study to study, with most being shown to be effective in altering mood (Zhang, Yu, & Barrett, 2014). The lab induced affect is typically similar to naturally occurring affect in terms of performance under lab conditions and both differ from the neutral control conditions (Curtus, 2013; Morgan, Jones, & Harris, 2013; Stanton, Reeck, Huettel, & LaBar, 2014). This similarity allows researchers to use mood induction procedures rather than relying on participants' state mood upon entry into the study.

There has been little to no research that tests the effectiveness of affective prosody as a sole prime in a mood induction procedure. Most studies rely on imagery, video, semantics and prosody, or some combination of these (Curtus, 2013; Stanton et al., 2014; Zhang et al., 2014). These studies have shown that a variety of procedures have effectively induced mood. This stresses the importance of this study which seeks to examine the influence of affective prosody without the possibility of semantic entanglement (without the possible interaction between non-verbal cues and word meaning). This direct approach permits for examination of the influence of affective prosody without the need to adjust for word meaning. This is the basis for the proposed study, which seeks to examine the possible relationship between affective prosody and decision

making by using an affective prosody mood induction procedure followed by a decision making task.

The Current Study

This study used affective prosody as the sole manipulation tool for the mood induction procedure. This was performed to eliminate any semantic entanglement. Participants then performed a decision making task similar to the Iowa Gambling Task. This study used the Hungry Donkey Task (Crone & van der Molen, 2004), a variation of the IGT adapted for use with children, which has been shown to be successful with both children and adults in measuring decision making. This study will eventually be performed with children in an attempt to determine what role development may play in the relationship between mood and decision-making. It was hypothesized that in the initial trials of the decision making task, individuals induced with positive affective prosody will be in a more positive mood and experience initial advantageous decision making, and individuals induced with negative affective prosody will be in a less positive mood and initially exhibit more disadvantageous decision making. This decision making pattern would then reverse in the later trials of the task.

This hypothesis was supported by previous studies that found similar results when examining mood on the IGT and similar tasks (Buelow & Suhr, 2013; de Vries et al., 2008; Suhr & Tsanadis, 2007). On the assumption that mood induced with affective prosody is similar to state mood, and mood induced through other mood induction procedures, the results should conform to prior studies using the IGT. It was hypothesized that participants in the positive affect condition would exhibit more advantageous decision making in the initial trials of the task compared to participants in the negative affect condition. The rationale behind this hypothesis stemmed heavily on past research suggesting that heuristic processing associated with positive mood leads to an initial advantage on the IGT (de Vries et al., 2008) and research suggesting that

negative affect (Suhr & Tsanadis, 2007) and negative state mood (Buelow & Suhr, 2013) are correlated with riskier decision making in early IGT performance.

Method

Participants

This study recruited participants from a regional campus of a large Midwestern university. The sample consisted of 130 participants. These participants were male (*n*=44) and female (*n*=58) undergraduate students between the ages of 18 and 44 (*M*=19.08 years, *SD*=3.38). These participants were predominantly Caucasian (*n*=76), followed by African American (*n*=13), and the remainder were Hispanic (*n*=3), Middle Eastern (n=2), multi-racial (*n*=4), and other (*n*=4). The participants were students enrolled in an introductory psychology course, whose participation in research earned credit toward a course requirement. The students had the opportunity to earn their credit through alternative measures, ensuring voluntary participation. Participants were randomly assigned into one of two mood induction groups (positive and negative) with approximately equal participants in each condition.

Based on responses to the demographic questionnaire, additional participants were excluded from the study including individuals who reported head trauma causing loss of consciousness (*n*=18), a first language other than English (n=2), an ADHD/ADD diagnosis without treatment (*n*=4), or reported untreated vision problems (*n*=2). Two participants were also excluded due to computer related issues, and one participant was excluded due to researcher suspicion of guessing sporadically. These exclusions led to 102 participants for the final analysis.

Materials

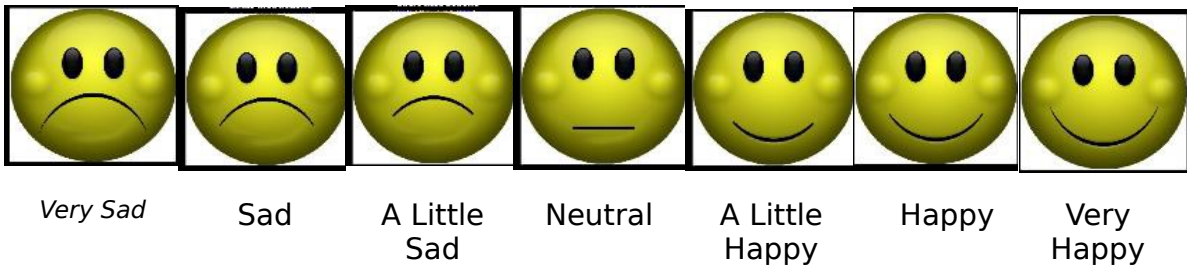
Mood manipulation. The mood induction procedure required the use of a neutral script (Appendix A) read in either positive (sounded happy) or negative prosody (sounded sad). The script was adapted from a previous study (Zhang et al., 2014), where it was used as the neutral condition in a guided imagery mood induction procedure. The script was extended using neutral content to ensure its ability to induce mood effectively. The scripts were pre-recorded (Saved as

VLC media files) by the same female speaker in both the positive and negative conditions; participants were presented the stimuli using a PowerPoint slide and listened to the recording through Kensington headphones set to a comfortable volume (20-22% volume setting). Participants in the positive group listened to the positive affective prosody recording, and those in the negative group listened to the negative affective prosody recording. These recordings were of different lengths due to the slower speech rate of the negative prosody recording (2:25 minutes) as opposed to the quicker speech rate of the positive affective prosody recording (1:38 minutes).

Mood measure. Upon completing the mood induction procedure, participants were asked to complete a mood measure. This measure was an adaptation of the child dental anxiety scale (Buchanan, 2005), which has been shown effective in measuring mood and fear in a clinical setting with children and adults. The measure utilized a seven point Likert scale, featuring faces and descriptors of mood below them (Figure 1). Participants were instructed to complete this measure by selecting the face that most described their current mood. This single item mood measure was used due to plans to perform this procedure with children.

Hungry Donkey Task (Decision Making Measure). The computerized Hungry Donkey

Figure 1: The self-report mood measure.



Task (Crone & van der Molen, 2004) used in this study was performed using Inquisit software. The task required the participant to select one of four doors in order to “Feed the hungry donkey by selecting the most favorable door.” The participant made selections throughout multiple

blocks of the task leading to a total of 400 selections. The task consists of a standard portion with 10 blocks of 20 trials (200 trials). This was followed by a reversed portion (200 trials), where the doors are rearranged (advantageous doors became disadvantageous and vice versa) in an effort to measure how quickly they learn the new system. This portion also consists of 10 blocks with 20 trials each. Participants took approximately 20 minutes to complete the task.

Scoring was determined by the participant's preference toward particular doors. Two of the doors were disadvantageous (high risk); the other two were advantageous (low risk). A net score was calculated for each block by subtracting the totals of disadvantageous door selections from the advantageous door selections. This calculation (advantageous selections minus disadvantageous selections) left a final net score for each participant for each block. Individuals who selected from the disadvantageous doors predominately received a lower score than individuals who selected from the advantageous doors. The systematic rigging of door payout was unknown to the participants upon entry into the simulation.

Generally, participants learn which doors are more favorable over the course of the task (Crone & van der Molen, 2004). This process of learning the task is believed to take approximately 40 trials (Brand et al., 2007). The task utilized a bar which displayed the win/loss data for each door (Figure 2). By examining preference, it is possible to identify when the participant learns this system. Due to the large amount of existing data on early performance on the IGT, this study examined the initial five blocks of performance (the first 100 selections of the total 400 selections) in an effort to determine if mood induced through affective prosody had an effect on the participant's selection. The Inquisit-based task also measures response time (milliseconds) of participants' door selection.

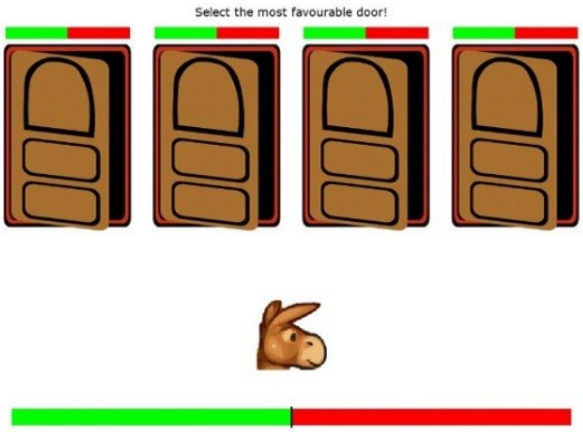


Figure 2: The Hungry Donkey Task, as seen by participants.

Demographic and Debriefing Materials. A demographic information sheet (Appendix B) was used to ascertain information about the participants such as age, gender, if they knew the purpose of the study, and other demographic variables. These included history of ADHD, vision problems, hearing problems, and any recent head trauma. These factors have been shown to lead to sub-optimal performance in the IGT and in the case of ADHD have been linked with pathological gambling (Abouzari, Oberg, Gruber, & Tata, 2015). These cases were excluded to ensure any performance differences were due to the manipulation and not these factors. The study utilized a paper/pencil demographic and debriefing form with contact information.

Procedure

Upon arrival, participants began a computerized Power Point consent process. This provided all the necessary details for informed consent. Participants were informed that this study would involve listening to a recording followed by a brief questionnaire. Then they would be asked to perform the Hungry Donkey task, followed by a second questionnaire. They were prompted to press a button to provide their consent.

Individuals were assigned to either a positive or negative group with up to three participants per session. Each session consisted of one affect condition (positive or negative).

This was due to the different recording lengths and fear that participants completing the prosody manipulation at different times would distract the other participants. Participants in the positive group listened to positive affective prosody. The negative group listened to negative affective prosody. The script used for both groups was the same; the only difference was the manner in which the script was read (i.e., affective prosody). Participants were prompted to listen to the recording through headphones which were set to a comfortable volume. The process was administered through a PowerPoint immediately following the consent portion. Once the participant had listened to the recording, they immediately were asked to complete the mood measure to gauge their current mood. This measure was in paper and pencil format; participants simply checked the most accurate description of their current mood.

Upon completion of the mood measure, the decision making task began. Once the Inquisit script was loaded by the researcher, participants were prompted to read the instructions on the computer screen and then begin the task. When the participant completed the full 400 trials, they were asked to fill out the demographic sheet located on the back of the mood measure. Finally, participants were debriefed and offered candy as mood repair. This was done to alleviate any negative mood they may have experienced while listening to the negative affective prosody recording.

Results

A manipulation check was performed to determine the effectiveness of the mood induction procedure. An independent samples *t*-test examined the effect of condition (IV) on the self-reported mood (DV). The test found a significant effect $t(100)=2.86$, $p<.01$; participants who listened to the negative affective prosody recording experienced less positive mood ($M=4.15$, $SD=1.24$) than the positive group ($M=4.78$, $SD=1.0$).

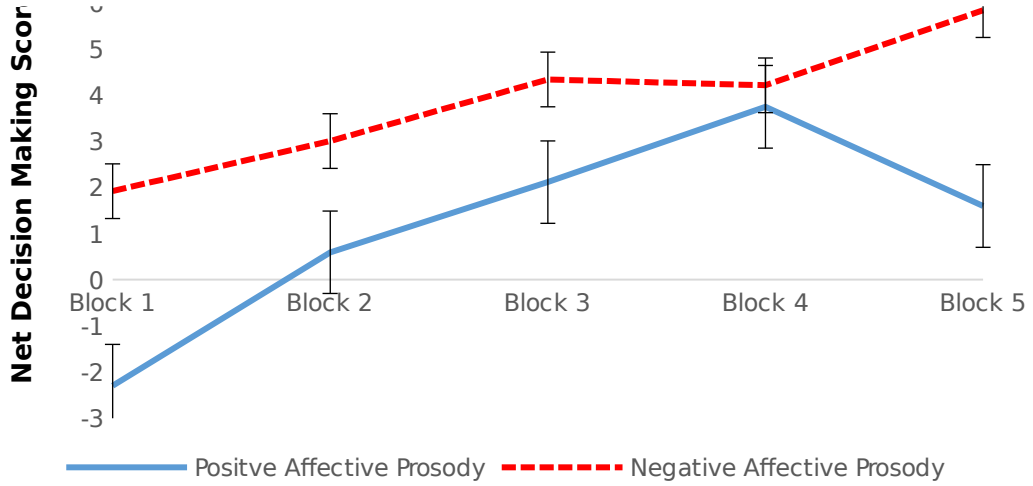
A net decision making score was calculated in intervals of twenty trials, leading to five block scores (trials 1-20, 21-40, 41-60, 61-80, and 81-100). The net scores were a comparison of

the selections of advantageous doors minus the disadvantageous doors for each participant in each block of trials. Participants who select from advantageous doors tend to have to a higher net score a higher score reflects more advantageous decision making (Bechara & Damasio, 2004). Only the first 100 trials were analyzed in order to most effectively examine performance in the portion of the task (trials 1-40) which are most heavily influenced by mood/emotional markers (Buelow et al., 2013). The remaining trials (41-100) are thought to represent participants' performance with regards to learned decision making strategies as opposed to emotional processing (Brand et al., 2007; Buelow et al., 2013). There were no main effects or interactions of gender in preliminary analysis, so gender was removed from subsequent analyses. Given the low variance within reported age, there was no analysis examining the effects of age on the decision making scores.

A correlational analysis displayed no significant relationships between self-reported mood and net score across the five blocks of the task *p*s>.067. Performance in the decision making task (net score) was examined across mood conditions (positive and negative). Using the affective prosody condition (positive or negative) as the independent variable and net score for each block (1-20, 21-40, 41-60, 61-80, and 81-100) as the dependent variable, a Repeated Measures ANOVA was performed to examine the effect of condition (positive or negative) on the net score on the decision making task. There was a significant between-subjects effect of condition, $F(1, 100)=6.40$, $p=.01$, $\eta_p^2=.06$; pairwise comparisons show that the negative affect group ($M=3.86$, $SD=1.48$) scored significantly higher than the positive affect group ($M=1.15$, $SD=2.24$) overall. There was also a significant within-subjects effect of net score, $F(4, 400)=9.01$, $p<.001$, $\eta_p^2=.08$; decision making improved as the task progressed. There was not a significant interaction between block and condition $F(4,400)=1.89$, $p=.112$., $\eta_p^2=.019$.; Exploratory analysis examined the scores broken down by interval, the negative group scored

higher than the positive group in the first (p<.001) and fifth block (p<.05) of the task. Due to a non-significant interaction these findings cannot be interpreted further.

Figure 3: Net decision making scores across the five blocks of the task.



Participants' reaction time was averaged across the first 100 trials of the task. A One-way ANOVA displayed a marginally significant effect of reaction time, $F(1,100)=3.12$, $p=.08$, such that the negative group (M=973.98 ms, SD=513.98 ms) took longer to respond than the positive group (M= 822.42 ms, SD=344.95 ms) on average.

Discussion

The significant effect of the affective prosody condition on the Hungry Donkey Task suggests that the mood manipulation procedure was not only effective in inducing affect but also altered performance in the decision making task. The manipulation check serves to suggest that the induced affect was in the desired direction, although the negative group reported a neutral mood and not a negative mood. The results may also serve as evidence that mood induced with affective prosody is similar to mood that naturally occurs or is induced through other techniques. The decision making results do not support the directional hypothesis, in that the positive group did not make better decisions than the negative group. The results instead show an advantage of the negative group throughout the first 100 selections of the task. More specifically, the negative

group had a higher preference for the advantageous doors leading to overall better decision making. This difference in decision making performance may suggest that the negative group processed the information more systematically and that this process led to better scores. This difference may also be explained by greater aversion to loss/risk seemingly exhibited by the negative condition's preference for advantageous doors within the first score interval.

The difference in performance may also suggest that heuristic processing is not as effective in the initial trials despite prior research suggesting it leads to an early advantage (de Vries et al., 2008). The results demonstrate that participants who were presented the positive affective prosody recording performed less advantageously on the Hungry Donkey Task. The results may suggest that the positive affective prosody recording was successful in influencing heuristic processing within participants that may have led to the poor results in the selections of the first set; this is also somewhat strengthened by the marginal difference in response time. The results suggest affective prosody has a significant effect on decision making behavior even when not linked with semantics.

The results from this study's decision making task match some previous research in the field of decision making and mood. Namely, that negative mood seems to elicit more advantageous decision making (Chou et al., 2007; Heilman et al., 2010; Smoski et al., 2008; Yuen & Lee, 2003). However, it does not correspond with other research which suggests that positive mood leads to an initial advantage (de Vries et al., 2008) and that negative affect has been correlated with more disadvantageous selections (Suhr & Tsanadis, 2007). The results in this study show the negative affect condition as eliciting more advantageous selections across both early trials (1-40) and later trials (41-100) of the task. The results also suggest that positive mood induces more disadvantageous selections. This research serves to strengthen the current evidence suggesting mood as having an effect on risky decision making in tasks similar in nature

to the IGT (Bechara et al., 1994). When coupled with the use of an affective prosody manipulation technique, the results suggest affective prosody significantly altered performance on the decision making task.

One possible explanation for this effect could be the overlap of activation that occurs in the frontal lobe during tasks involving decision making and during comprehension of affective prosody. The theory behind this lies in the current research which suggests that portions of the ventral medial prefrontal cortex are involved in both the processing of emotions and is activated during tasks that involve risky decision making. This area has also been shown to be activated during comprehension of affective prosody. Since these results implicate affective prosody as being an influencing factor in the decision making task, these results support a more substantial role of affective prosody in daily life. Given the activation of the frontal lobe that occurs during comprehension of affective prosody (Morris et al., 1999; Schirmer & Kotz, 2006), speculation may be made into the possible interaction that is occurring when affective prosody is being used as a mood manipulation.

The implication of affective prosody as being influential in cognitive tasks may be suggested from these results. Through usage of a semantically neutral script, it was ensured that semantic entanglement did not occur; thus, successful mood manipulation was due solely to the prosodic content within the recording itself and not by the emotional meaning of the words. This result suggests that mood was successfully manipulated through prosody. Affective prosody is an important aspect of human language; though it is typically thought of with regards to the meaning of the words being spoken. For example, when an individual argues with another, they may use words carrying aggressive meaning along with an angry voice in an effort to convey anger. Semantics and prosody typically work in collaboration; however, this study provides

evidence that affective prosody does influence mood, and it can do so without the aid of sematic information.

Results from this study also serve to introduce the possibility of affective prosody as an effective tool for mood manipulation in the field of research. The affective prosody procedure used is relatively short in length. This could prove valuable to researchers in the field of mood, who require the use of a quick and simple mood manipulation. Given the simplicity of the induction procedure, it allows for simple follow up studies with young children. From a developmental perspective, the implication of affective prosody as altering performance in decision making is significant. Given the overlap of activation in the prefrontal cortex, it could be speculated that as the frontal lobe develops through childhood (Diamond, 2002; Tsujimoto, 2008), both affective prosody comprehension and decision making may become more susceptible to affect as the frontal lobe continues to develop. This effect of prosody on decision making would also prove useful in childcare. If a caregiver wishes the child to exhibit better decision making strategies, then perhaps a more somber/neutral tone may actually assist.

Finally, a possible explanation for the effect of response time may actually be the different speech rates of the two conditions. The negative prosody recording used slower speech and led to slower response times. Prior research in speech rate priming suggests that speech production may be influenced by the others' speech rate (Jungers & Hupp, 2009). This priming effect has also been found with regards to visual processing, such that participants viewing moving stimuli matched their speech rate to the movement speed of the stimuli (Hupp & Jungers, 2013). Participants also exhibit faster response times in a subsequent task after listening to instructions with a faster speech rate (Shintel & Nusbaum, 2008). The difference in speech rate between the positive and negative condition may have led to this effect of condition on response time. Namely, the negative condition was primed by the slow speech in the recording, and their

decision making time was slowed as a result. Listening to slower speech led to slower behavior. This slowed decision making may have led to greater elaboration on the part of the participant and better decision making.

Limitations

One possible limitation may be the script used. During the development of this study, a neutral script was sought which had been shown neutral in semantic meaning by a previous study (Zhang et al., 2014). In order to ensure a strong enough effect, this script was lengthened using similar neutral content. Great care was taken to ensure that the script remained neutral, but it is possible that the wording of the script may have biased both groups in a positive direction. In addition, future research may seek to utilize a more sensitive mood measure, such as the Positive and Negative Affect Schedule (PANAS: Watson, Clark, & Tellegen, 1988), in order to more appropriately quantify the effect the script is having on mood.

The stimulus used in the mood manipulation led to a significant difference between the two conditions, but the results were not as robust as manipulations performed along with semantic information. The negative condition did not have an overall negative self-reported affect. Instead it was merely less positive than the positive condition basically resulting in a neutral mood. This negative affective stimulus was also performed at a slower pace than the positive stimulus; which led to a longer recording length. Future research should ensure equal length among stimuli to ensure that script length did not act as a confounding variable. Given the long length of the negative script and its poor performance, it may be possible that it was not effective in inducing negative mood but rather maintained/induced a neutral mood. Future research may be performed with the addition of a control group (either a neutral prosody group or no script group) to compare the negative group with in an effort to determine effectiveness of the procedure used in this study.

A pre/posttest design may also be beneficial in order to determine if the mood induction procedure is effective and would also allow for examination of the length of the effect. This study is unable to determine the longevity of the induced mood; additional measures after the task would allow for examination of the length of the effect. Conclusions from this research should be interpreted with caution given the inability to determine if the difference seen here is a result of differences between a positive and negative mood group; or between a positive and neutral group. Differences still persist between the groups, but future research may reinforce understanding of the influence mood and affective prosody may have on decision making.

Future Research

Future studies may seek to determine to what level prosody must be presented in order to induce mood. For example, by adjusting tone, rate, or other aspects of speech it may be possible to examine many different forms of affective prosody, such as angry, scared, etc., to determine if these share similar characteristics as the positive (happy) or negative (sad) recordings which were used in this study. Furthermore, this would also permit exploration into the lack of negative induced mood. Future studies may seek to examine if negative mood induction is possible, this may involve the use of a more sensitive mood measure. This study was designed in a manner that would allow for examination of affective prosody and decision making in children. This would permit examination of the effect developmentally. Since development of the prefrontal cortex is still underway in children (Diamond, 2002; Tsujimoto, 2008), performance on the task can be tracked and linked with this development in an effort to establish a timeline of development regarding affective prosody comprehension and decision making. The potential priming effect of speech rate may also be explored by utilizing new recordings matched in all vocal aspects except for speech rate. This would permit for examination of the possibility of speech rate as priming

decision making speed without the confounding tone/rate interaction which may be a factor in this study.

Conclusion

This research serves to support the idea of a complex and dynamic activation of neural pathways that occurs during comprehension of affective prosody and in making decisions. The affective prosody mood manipulation was shown as having a significant effect on mood and an unrelated cognitive task. It provides more evidence of the relationship between affective prosody and mood given that mood was successfully induced via affective prosody. This relationship between affective prosody and emotional processing has been speculated to exist to some degree; this study provides evidence of affective prosody's influence on mood, and demonstrates that affective prosody can influence mood (at least in a positive direction) without the entanglement of semantic information.

The results also add to the literature on mood and decision making, by lending support to past claims of negative mood leading to advantageous decision making (Chou et al., 2007; Heilman et al., 2010). However, this study conflicts with other research suggesting positive mood as being advantageous (de Vries et al., 2008). This study also introduces the possibility of speech rate as being a direction for future decision making research. The effect found in this study may be a result of the differing speech rate of the two recordings directly affecting the speed of decision making. This aspect of speech could be explored in greater depth to examine the possibility of speech rate priming. It is hopeful that this will spur future research in a direction to examine the effect of prosody and its various aspects on decision making.

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Appendix A

Neutral Script

You are walking down a street. You have your music player on and you are listening to a song. You don’t have anywhere to go, so you just decided to take a walk and be outside for a bit. Your pace is slow and easy. There is a slight breeze picking up. You can feel it brush against your skin. You look around and see that the trees are starting to turn red and orange and gold. The sun is high in the sky and you put on your sunglasses. You watch a few cars drive past you on the street. You continue walking down the street. You feel your backpack on your back moving to the same rhythm as your walk. In the distance you hear a dog barking. You look down the street. You count the number of street lamps. One, two, three, four, five, six, seven. You see a store window filled with vegetables and other produce. As you pass you see a store clerk sweeping the floor. You continue down the street and pass by someone walking a dog, and you wonder if it was the same dog you heard earlier. You decide to sit down at a bench nearby. The sun is slowly covered up by the clouds and you remove your sunglasses. You see a bus pass by. You see people on board but cannot make out the faces of those inside. With the sun down, the breeze begins to feel a bit cooler. You put on the jacket you had packed in you backpack. You check the time. You decide to start your walk back to your home. As you walk you start to count the number of street lamps again, one, two, three, four…

Appendix B

Participant Demographic Information

In order to determine whether the results of our study apply to the general population or only to a specific subset, we ask that you take a few minutes to complete the following information. This information is for descriptive purposes only and will remain strictly confidential. Please do not put your name on this form. We appreciate your help and your willingness to cooperate in our research. Thank you.

AGE: _____ SEX: _____ Male _____ Female

RACE/ETHNICITY:

_____ White/Caucasian

_____ Black/African-American

_____ Hispanic

_____ Middle Eastern

_____ Multi-racial

_____ Other (Please Specify) _____

EDUCATION STATUS:

Year in College: _____ Major: _____ GPA: _____

Do you have a vision problem? _____ YES _____ NO

If yes, has it been corrected (Glasses/contacts, surgery, etc.)? ____YES _____NO

Do you have a hearing problem? _____ YES _____ NO_

If yes, has it been corrected (hearing aids, etc.)? _____YES _____NO

Do you have any attentional issues such as Attention-Deficit/Hyperactivity Disorder (ADHD or ADD)? _____ YES _____ NO

If yes, are you currently being treated for these issues? _____YES _____NO

Have you experienced a head injury in which you lost consciousness for several minutes or longer? _____YES _____ NO

Is English your first language? _____ YES _____ NO

If no, what is your first language? _____

What was the purpose of this study?