EXAMINING WHETHER INSTRUMENT CHANGES AFFECT SONG RECOGNITION THE WAY TALKER CHANGES AFFECT WORD RECOGNITION

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ABSTRACT

In this study, I examined whether or not the representations underlying music processing and spoken word recognition are similar. Previously, *talker effects* -an advantage for recognizing a repeated word spoken by the same talker relative to two different talkers - have been found when processing is relatively slow (McLennan & Luce, 2005). Research has previously shown that there are similarities between language and music (Patel, 2003; Lim & Goh, 2012; McMullen & Saffran 2004). Therefore, I extended previous work on talker effects to music perception by examining whether or not I would obtain *instrument effects* - an advantage for recognizing a repeated song played by the same instrument relative to a different instrument. That is, I compared listeners' responses to songs were repeated across two blocks of trials when the instrument remained the same (e.g., harp to harp) and when the instruments changed (e.g., harp to trumpet). The results demonstrated that the instrument match condition was significantly faster than the instrument mismatch condition, demonstrating instrument effects. Results support the notion that the representations underlying language processing are analogous to the representations underlying music processing.

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CHAPTER I

INTRODUCTION

When processing language, listeners typically understand spoken words quickly and accurately, despite the high degree of variability in speech, as a consequence of different talkers, emotional tones of voice, speaking rates, and so on. However, there are two theories regarding how listeners represent spoken words: episodic and abstract.

Episodic theories (Goldinger, 1996) posit that when individuals process spoken words, nonlinguistic – or indexical – features are stored as part of the lexical representations. Indexical features capture the variability in speech, such as the talker's identity, emotional tone of voice, and speaking rate (Abercrombie, 1967; Pisoni, 1997).

On the other hand, according to abstract theories (McClelland & Elman, 1986; Pisoni, 1997), when processing spoken words, these nonlinguistic features are not stored as part of listeners' lexical representations. Abstract theories follow a speech normalization process, in which nonlinguistic features are stripped off during processing in order to store the phonological features or the underlying linguistic code (Mullennix, Pisoni, & Martin, 1989). Normalization and abstract theories contrast with the episodic theory, which again claims that these nonlinguistic features are stored as part of listeners' lexical representations.

Talker Effect

Church and Schacter (1994) examined how listeners represent and process spoken words using a long-term repetition-priming paradigm. Participants were presented with two blocks of spoken words. The first block is referred to as a prime block and the second block is referred to as a target block. Between the blocks, a filler task was given. According to Church and Schacter, when the words were repeated (i.e., appeared in both the prime and target blocks), participants responded quicker and with a higher accuracy rate, than when a new, non-repeated (i.e., unprimed or control) word was presented, known as a *long-term repetition priming effect*. Additionally, participants responded slower and with less accuracy when the repeated words were spoken by a different talker in the prime and target blocks, relative to when the repeated words were spoken by the same talker in the two blocks, known as a *talker effect*.

McLennan and Luce (2005) demonstrated that talker variability influences individuals' perceptions when listening to spoken words. That is, talker effects emerged, when given a hard task, which is consistent with episodic theories. McLennan and Luce (2005) proposed the time-course hypothesis in order to account for apparently conflicting findings in the literature. That is, as mentioned, some results support abstract theories, and others support episodic theory. According to the time-course hypothesis, when processing is slow, talker effects emerge, which is consistent with episodic theories. In contrast, when processing is fast, talker effects fail to emerge, and priming is equivalent for the match and mismatch conditions, which is consistent with abstract theories.

An 'indexical' specificity effect was expected to emerge in this current study, demonstrated by a significant difference between the match and mismatch conditions for 'intact' songs in a hard lexical type decision task. These results were consistent with episodic theories. Episodic theories (Goldinger, 1996) suggest when individuals process spoken words, nonlinguistic – or indexical – features are stored as part of the lexical representations. Based on these results the data would imply that the time-course hypothesis may be demonstrated by further research[1], which would be consistent with McLennan and Luce (2005).

Further research by Mattys and Liss (2008) also found support for the time-course hypothesis when utilizing degraded speech (dysarthria), to replicate similar findings without using simulated speech which caused a less than ideal form of listening. Three levels of difficultly were constructed by creating three different types of speech: a woman and man with no speech impairments, a woman and man with mild dysarthria, and a women and a man with severe dysarthria. Within each trial each participant only heard one type of speech. It was predicted that talker effects would be greater for stimuli with spoken words from individuals with dysarthria verses the words spoken with normal speech. Results showed that when the level of speech difficulty increased so did specificity effects for spoken words. The research also demonstrated as the difficulty increased the participants processing slowed which is consistent with the time-course hypothesis.

González and McLennan (2007) studied hemispheric differences of indexical specificity effects in spoken word recognition using a lexical decision task with the use of

[1] The author completed further research and is in the process of analyzing the data.

long-term repetition-priming paradigm. Results showed that when the auditory stimuli were presented to the left ear (right hemisphere), the prime was more effective when the prime and target words were spoken by the same talker compared to when the prime and target words were spoken by two different talkers. When the auditory stimuli were presented to the right ear (left hemisphere), repeated words were primed equally well when spoken by the same talker and when spoken by a different talker. These results suggest that specificity effects affect the perception of spoken words differently in the right and left hemispheres.

In a separate study, González and McLennan (2009) found the same pattern of specificity effects for environmental sounds. Additionally, with the use of environmental sounds, these results suggest that specificity effects affect the perception environmental sounds and spoken words similarly.

Music and Language

Language and music have been shown to have similar features as well as commonalities in processing (McMullen & Saffran 2004; Patel 2003). Similar basic features include how phonemes are merged to form sentences and how music notes are joined to create melodies. Additionally, these basic features have a uniform structure that demonstrates prosodic structure in language and rhythmic structure in music (Lim & Goh, 2012).

Adorno (1993) argued that music and language hold many more similarities than the basic features mentioned. Similar to language, music requires interpretation and can be mimicked without the individual understanding the 'rules' associated to making music. Stravinsky (1882-1971) sought not only to push "musical design" but also diversify music from language by trying to eliminate music models that have been compared to language as similarities. However, Stravinsky was unsuccessful; his music still contained the parodistic[2] elements that were related so closely to language. Adorno (1993) further explains that music and language will remain similar because both imitate and follow structure that cannot be removed. In conclusion, at an abstract level, Adorno (1993) provides evidence that music and language are analogous due to their linguistic elements, constructs, and ability to encode feelings to another individual.

Lim and Goh (2012) examined to what extent indexical effects in non-lexical (voice) and non-musical (timbre[3]) word/melody recognition are similar. Their results demonstrated that when the same melody was played in a short-term repetition-priming paradigm, participants were faster and more accurate, which is consistent with previous findings (Goh, 2005). Additionally, when the timbre was similar to the original timbre presented, speed and accuracy were equivalent. Results by Lim and Goh (2012) suggest that timbre-specific information is encoded and stored into long-term memory. Additionally, these findings suggest that indexical effects from non-lexical (voice) and non-musical (timbre) sources of information may be analogous in their representation and processing.

Instrument Gender

Similar to talkers in spoken language, instruments can also be perceived as being associated with gender. Griswold and Chroback (1981) examined perceived sex stereotyping of musical instruments in undergraduate students (music majors and non-

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[2]Defined as a literary imitation or characteristic style.

[3] Defined as a characteristic or quality of musical sound/voice, which is separate from the pitch and intensity.

music majors). Participants were presented with a list of 17 musical items and were asked to rate each item on a Likert scale (1 feminine - 10 masculine) to indicate the degree to which each item associated with the corresponding gender. The results demonstrated that there were no differences for participant gender, but there were differences between music majors and non-music majors in their perceptions of the sex associated with each instrument (Griswold & Chroback, 1981). Music majors rated clarinet and string bass as more masculine when compared to non-music majors. It was concluded that harp had the strongest female association, and tuba had the strongest male association[4].

In further research, Kelly and VanWeelden (2014) investigated gender association in secondary school music students using world musical instruments. Students were presented with 10 world instruments within one assigned condition: auditory only, visual only, or visual and auditory. Additionally, each student completed a survey to specify his or her perception of each instrument's gender association. The results showed that regardless of gender the students' perception of individual instruments were consistent with how instruments from the USA were perceived (Kelly & Van Weelden, 2014). The instruments' perceived size played a role in gender association[5]. Although timbre did not make a difference in this experiment, other research has shown that instruments' timbre can also influence the perception of gender (Kelly, 1997). The null effect of timbre in the Kelly and Van Weelden (2014) study could be due to the fact that those instruments from around the world were unfamiliar to the participants. However, the differences between these studies suggest that timbre may be inconsistent across instruments and pitches.

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[4]Instruments with the strongest female association, in order: harp, flute, and piccolo. Instruments with the strongest male association, in order: tuba, string bass and trumpet.
[5]Larger instruments were seen as more masculine while smaller instruments were seen as more feminine.

Additional research by Payne (2014) investigated whether or not there were relationships between a student's personality traits and his or her timbre preference. Students completed the Adolescent Personal Style Inventory (APSI) and the Instrument Timbre Preference Test (ITPT). The results indicated that openness and extraversion were primary indicators of timbre preference (Payne, 2014). Openness was a positive predictor for flute, clarinet, saxophone and horn, and a negative predictor for trumpet, trombone, Baritone, tuba and horn (Payne, 2014). Interestingly, openness and extraversion appear to be opposite for every instrument except tuba and flute[6]. These findings suggest there is a correlation between gender and timbre preference regardless of the participants gender.

Current Study

In the current study, I examined whether or not I would obtain a similar finding in music processing as has been found previously in language processing. Talker effects – a reduction in priming when a different talker relative to the same talker repeats a word - have been found previously when processing was relatively slow (M^cLennan & Luce, 2005). I attempted to extend this previous work to instrument specificity effects. That is, I examined whether there would be a reduction in priming when a different instrument relative to the same instrument repeated a song clip. Previous research has shown that there are similarities within basic features and structure for language and music (Patel, 2003; Lim & Goh, 2012; McMullen & Saffran 2004). If specificity effects are found in

[6]When openness was positive, extraversion was negative and likewise when openness was negative, extraversion was positive. This remained true for all instruments except for flute and tuba. Flute had a positive predictor for openness only. Tuba was the only instrument to have a positive predictor for agreeableness and two negative predictors for extraversion and openness. Additionally, Oboe and Bassoon has no predictors.

the current study among, such a finding would provide further evidence that the representations underlying language and music processing are analogous.

I hypothesize that the results will mimic those of McLennan and Luce (2005) in their slower condition in which participants performed a hard lexical decision task. In particular, I hypothesize that instrument specificity effects will emerge because processing will be relatively slow in a task intentionally designed to be analogous to a hard lexical decision task. In other words, when the instrument matches in the prime and target blocks, reaction times are predicted to be faster than when the instrument mismatches.

CHAPTER II

EXPERIMENT: HARD DECISION TASK

Method

Participants. Forty-seven participants were recruited from the Cleveland State University community. Six participants were removed from the analysis; five participants were removed due to a coding error and one participant was removed for falling more than two standard deviations below the overall mean RT. The sample size was obtained from a power analysis (G*Power 3, 2007). Participants from psychology classes received 0.5-research participation credit. Participants were between 18 to 30 years of age, right handed, native-speakers of American English with no current speech or hearing disorders. All participants read and signed an informed consent form before the start of the experiment, and all APA/IRB ethical guidelines were followed.

Materials. A Macintosh, iMac Desktop 1.83GHz Intel Core 2 Duo, pre-loaded with SuperLab 4.0 was used in a quiet lab space with a 1440 x 900 Resolution 17-inch Macintosh display screen. A response pad (Model RB-730) was provided to each participant to enable personal participant response and reaction times. One pair of Standard Sony headphones was also provided to each participant before the study to enable personal auditory listening of the song clip stimuli.

The auditory stimuli[7] [8](Appendix A) consisted of 12 'intact' experimental melodies, 12 'distorted' songs that sound close to the 'intact' version of the song, eight

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[7] **Screening A.** Fifty-one different participants screened the auditory stimuli and were recruited from the Cleveland State University community. Participants from psychology classes received 0.5-research participation credit. Participants were between 18 to 30 years of age with no current speech or hearing disorders. All participants were provided with an informed consent before the start of each experiment, and all APA/IRB ethical guidelines were respected. Participants were randomly assigned to one of two groups (harp or trumpet). Each participant listened to 57 stimuli in the assigned group (19 'intact' songs, 19 'distorted' songs that sound close to the 'intact' version of the song, 19 'distorted' songs that do not sound close to the 'intact' version of the song). Each participant was asked to respond to each stimuli as a 'intact' or 'distorted', then participants were asked to rate how confident they are in their response of 'intact' or 'distorted', finally, participants were asked to identify the instrument of the stimuli previously presented from a list of six instruments (trumpet, tuba, string bass, harp, flute and piccolo) for each trial. 'Intact' songs were accurately identified 84.7% of the time with high confidence ratings of 5.45, 'distorted' songs that did not sound close to the 'intact' version of the song were accurately identified 68% of the time with a medium confidence rating of 4.57 and 'distorted' songs that sound close to the 'intact' version of the song were accurately identified 58% of the time with medium confidence rating of 4.7. Therefore, participants were able to distinguish between the song types.

filler songs (four 'intact' & four 'distorted'), and four practice songs (two ‘intact’ & two ‘distorted’).

Stimuli were composed using Finale 2009 software as .wav files for two instruments (harp & trumpet)[9]. Each song stimuli lasted approximately four to six

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[8] **Screening B.** Thirty-eight different participants screened the auditory stimuli and were recruited from the Cleveland State University community. Participants were from psychology classes received 0.5 research participation credit. Participants were between 18 to 30 years of age with no current speech or hearing disorders. All participants were provided with an informed consent before the start of each experiment, and all APA/IRB ethical guidelines were respected. Participants listened to pairs of 19 'intact' songs consecutively (harp and trumpet). Each participant was asked to identify if the instrument (harp and trumpet) of each pairing was the same or different. Participants accurately indicated if the pairing was the same or different instruments (Table 1). Therefore, participants were able to distinguish between harp and trumpet timbre.

Table 1

Song and Instrument Recognition in Screening B

	Harp	Trumpet	Different	Mean
Song Recognition	93.13%	92.63%	100%	95.25%
Instrument ID	99%	99.5%	94.42%	97.64%
Overall Mean	96.1%	96.1%	97.21%	96.45%

Note. Song recognition is a participants ability to correctly recognize a song was the same or different as the previously played song. Instrument Id is a participants ability to correctly identify the instrument played.

[9]Dr. Lim at National University of Singapore, Singapore in the Department of Psychology prepared all of the auditory stimuli.

seconds due to the variability in song composition (constant across instrument and song type).

Musical pieces and songs (without lyrics) deemed as popular, accessible selections by one of our collaborators (Dr. Stephen Lim) and his research assistant with substantive musical training in both classical and popular musical genres were chosen[10].

Design. The design followed the same long-term repetition-priming paradigm used in M^c^Lennan and Luce (2005). The experimental stimuli were presented in two separate blocks: prime and target. The target block stimuli either matched, mismatched, or were completely different from (control) the prime block stimuli. Instruments in the matched condition were identical (e.g., *Star Wars*$_{\text{trumpet}}$, *Star Wars*$_{\text{trumpet}}$; *Star Wars*$_{\text{harp}}$, *Star Wars*$_{\text{harp}}$). Instruments in the mismatched condition were different (e.g., *Star Wars*$_{\text{trumpet}}$, *Star Wars*$_{\text{harp}}$; *Star Wars*$_{\text{harp}}$, *Star Wars*$_{\text{trumpet}}$).

The prime and target blocks consisted of 48 stimuli total (12 'intact' songs and 12 'distorted' songs that sound close to the 'intact' version of the song). The prime block consisted of 24 song stimuli: eight 'intact' songs, 8 'distorted' songs that sound close to the 'intact' version of the song and eight unrelated songs (four ‘intact’ & four 'distorted' songs that sound close to the 'intact' version of the song). The target block consisted of 24 songs (12 'intact' songs and 12 'distorted' songs that sound close to the 'intact' version of the song). In the target block, four of the ‘intact’ experimental songs matched, four mismatched, and four were controls.

Two notes in each melody (lasting 3.1s; three notes in each longer melody lasting 5.5s) were altered to obtain a consistent proportion of change per melody across all

[10] Both songs types were studied for future research and the possibility of an easy version of the task, but it is beyond the scope of this thesis research.

melodies. In the major distortion condition, the overall pitch contour (Peretz, 1990) and onset of the melody (Berger, 1964) were always changed in order to reduce the melodies' intelligibility (but also see Lim & Goh, 2013, for contrasting evidence), whereas in the minor distortion condition, the overall pitch contour of the melodies was always retained, and the alteration never occurred at the onset (i.e., first note) of the melody. The stimulus set contained 19 monophonic melodies. These melodies were scored using the *MuseScore* music notation software, reproduced in either of two instruments – harp or trumpet – and in their original musical keys or, in the absence of any such keys, in C major or C minor to insure consistency across all stimuli, and exported as .wav sound files.

Each melody lasted between 3.1 seconds and 5.5 seconds. Musical pieces and songs (lyrics, if any, were removed) deemed as popular, accessible selections by the 3rd author and his research assistant with substantive musical training in both classical and popular musical genres were chosen, and verified through a pilot test that they indeed were easily recognizable by non-expert music listeners before being deployed for the actual experiment.

Although the preparation of the 'distorted' songs that sound close to the 'intact' version of the song and their rotation through the various conditions paralleled the 'intact' song experimental stimuli, the 'distorted' songs that sound close to the 'intact' version of the song and the unrelated control stimuli ('intact' songs and 'distorted' songs that sound close to the 'intact' version of the song) were fillers. Therefore, the focus of the experimental manipulations and later statistical analyses were limited to the experimental 'intact' songs.

An orthogonal combination of the three prime levels (match, mismatch, and control) and two levels of instrument type (harp and trumpet) were distributed into six conditions for both types of songs ('intact' and 'distorted) (Table 2). Across participants, each song (both 'intact' and 'distorted' songs that sound close to the 'intact' version of the songs) played by each instrument type appeared in every possible condition.

Additionally, all stimuli were counterbalanced across all six versions of the experiment. No participant heard the same version of a song more than once within a block. For example, if a participant heard "Star Wars" in one of the blocks, he or she did not hear another version of that song again in the same block.

Table 2. *Experimental Conditions and Examples of Primes and Targets*

Condition	'Intact' Songs	
	Prime	Target
Match		
trumpet prime → trumpet target	*Star Wars*$_{\text{trumpet}}$	*Star Wars*$_{\text{trumpet}}$
harp prime → harp target	*Star Wars*$_{\text{harp}}$	*Star Wars*$_{\text{harp}}$
Mismatch		
trumpet prime → harp target	*Star Wars*$_{\text{trumpet}}$	*Star Wars*$_{\text{harp}}$
harp prime → trumpet target	*Star Wars*$_{\text{harp}}$	*Star Wars*$_{\text{trumpet}}$
Control		
Unrelated prime → trumpet target	*Für Elise*	*Star Wars*$_{\text{trumpet}}$
Unrelated prime → harp target	*Für Elise*	*Star Wars*$_{\text{harp}}$

Procedure. Upon arriving to the laboratory, each participant was given an informed consent (Appendix B), participants then completed a demographics questionnaire (Appendix C), a handedness inventory (Cohen, 2008; Appendix D), adapted from the Edinburgh Inventory (Oldfield, 1971), which is an objective measure of right- or left-handedness of the individual, and a race, ethnicity, and gender questionnaire (Appendix E).

Participants were tested in a quiet room individually and were not told at the beginning that there were two blocks of trials. Participants read the instructions on the computer screen (Appendix F). Participants were instructed to respond as quickly and as accurately as possible to indicate whether the song was an 'intact' song or a 'distorted' song. Participants indicated their responses by pressing the green ('intact' song; right thumb) or the red ('distorted' song; left thumb) button on a response box that was positioned directly in front of them. The participants first completed the prime block, then a math test (Appendix G) for approximately 3-5 minutes. The math test was given as a filler task between the prime and target blocks. Finally, the participants completed the target block.

All auditory stimuli were presented binaurally over headphones. After the participant responded to the presented stimulus, the next trial began. If a participant did not respond after 5 seconds, the computer automatically recorded the incorrect response and presented the next trial. A Macintosh computer with SuperLab controlled the stimulus presentation and recorded participants' reaction times and percentages correct to make correct intact or distorted song decisions. Stimulus presentation within each block was randomized for every participant. Reaction times were measured from the onset of each song stimulus until the onset of each participant's button press response.

After each participant completed the song type (intact or distorted) decision task, participants were asked to complete a post-experiment questionnaire. The post-experiment questionnaire was comprised of 10-point Likert scales, multiple-choice questions and open-ended answers to questions, all displayed on a computer screen (Appendix H).

First, the participants were asked to rate a list of musical instruments on a Likert scale of 1 to 10 on how masculine or feminine the instruments are (see Griswold & Chroback, 1981). Next, participants were asked to answer a series of questions about their own musical talent/capabilities. Finally, the participants were asked if they experienced any difficulty deciding weather a stimuli was an ‘intact’ song or 'distorted' song during the experiment and what they thought the purpose of this experiment was. Lastly, participants were debriefed, and provided with a debriefing form (Appendix I).

CHAPTER III

RESULTS

The study examined whether or not similar finding in music processing were possible when compared to previous research in language processing. Talker effects – a reduction in priming when a different talker relative to the same talker repeats a word - have been found previously when processing was relatively slow (M^{c}Lennan & Luce, 2005). This work attempted to extend instrument specificity effects. That is, examine whether there would be a reduction in priming when a different instrument relative to the same instrument repeated a song clip. Previous research has shown that there are similarities within basic features and structure for language and music (Patel, 2003; Lim & Goh, 2012; McMullen & Saffran 2004).

Six participants were removed from the analysis; five participants were removed due to an coding error and one participant was removed for falling more than two standard deviations below the overall mean RT. Reaction times were based on the exclusionary criteria followed by M^{c}Lennan and Luce (2005) of less than 500 ms or greater than 5,000 ms. Additionally, any participants whose overall mean RT fell below two standard deviations past the overall mean were remove from the analysis.

Two separate 3 (Prime Type: Match, Mismatch, Control) X 2 (Target Instrument: harp or trumpet) completely within-participants ANOVAs were performed, one on mean percentages correct and one on mean RTs to correct responses to the 'intact' stimuli in target block[11]. The design of the experiment used counterbalanced lists, so that each item appeared in every condition across participants.

The mean RT for 'distorted' songs that sounded close to the 'intact' versions of the songs were slower than the 'intact' versions of the songs, similar to findings in spoken word recognition in which RTs to non-words are slower than RTs to real words (Table 3). However, responses to these 'distorted' songs are not the primary focus of this study, and thus are not discussed further.

Table 3. *Song type mean reaction times in milliseconds (ms)*

Song Type	Match	Mismatch	Control	Mean
Overall Intact	2832.7 (123.1)	2991.4 (164.8)	3189.7 (106.1)	3004.6
Overall Distorted	2515.9 (203.2)	3052.0 (189.5)	2917.0 (238.3)	2828.3
Trumpet	2752.4 (147.4)	3065.5 (140.9)	3094.0 (126.6)	2970.6 (120.7)
Harp	2913.1 (127.9)	2917.3 (139.0)	3285.4 (138.1)	3038.6 (133.1)

The mean RTs as a function of condition, magnitudes of priming (MOP), and the match and control conditions. MOS is the difference in RTs between the match and mismatch conditions. There was a significant main effect of Prime for reaction time $F(2,70)$ =

[11] Given the design, which includes a counterbalanced list, each items appeared in every condition. Two dummy variables were created to represent an allocation of participants to the experimental list were included in the ANOVAs. Effects involving the dummy variables were not reported due to the dummy variables are solely to reduce random variation (see Pollatsek & Well, 1995).

10.27, $p < .001$, $\eta_p^2 = .23$. Planned comparisons based on this significant main effect of prime revealed a significant MOP $F(1,35) = 17.95$, $p < .001$, that is the match condition was significantly faster than the control condition and a significant MOS $F(1,35) = 3.97$, $p=.021$, hat is, the match condition was significantly faster than the mismatch condition. There was no significant difference between the mismatch and control conditions.

The mean percent correct for 'distorted' songs that sounded close to the 'intact' versions of the songs were not less correct than the 'intact' versions of the songs, contrary to the findings in spoken word recognition in which percent correct of nonwords are slower than percent correct to real words (Table 4).

Table 4. *Mean percent ages correct as a function of Song Type and Condition*

Song Type	Match	Mismatch	Control	Mean
Intact	79.0 (4.1)	80.5 (4.2)	74.1 (3.2)	77.87
Distorted	67.6 (4.0)	71.5 (4.7)	69.8 (4.0)	69.64
Trumpet	78.4 (5.6)	79.1 (5.5)	67.8 (4.6)	75.1 (3.9)
Harp	79.7 (4.6)	81.8 (4.7)	80.4 (5.2)	80.6 (3.3)

The mean percent correct as a function of condition, magnitudes of priming (MOP), and magnitude of specificity (MOS) were calculated. MOP is the difference in percent between the match and control conditions. MOS is the differences in percent correct between the match and mismatch conditions. There was not a significant main effect of Prime[12]. Additionally, comparisons revealed there was no significant for MOP

[12] $p>.05$

or MOS (Table 3). Additionally, there was no significant difference between the mismatch and control conditions[13].

[13] Additional analyses on gender and major were conducted to account for variance, however no additional analyses were significant.

CHAPTER IV

DISCUSSION

In the current study I examined whether or not a similar finding in music processing would be obtained as had been found previously in language processing. Talker effects – a reduction in priming when a word is repeated by a different talker relative to the same talker - have been found previously when processing was relatively slow (M^{c}Lennan & Luce, 2005). In this study I attempted to extend this work to instrument specificity effects. That is, I examined whether there would be a reduction in priming when a different instrument relative to the same instrument repeated a song clip. Previous research has shown that there are similarities within basic features and structure for language and music (Patel, 2003; Lim & Goh, 2012; McMullen & Saffran 2004).

Specificity effects were obtained when examining RTs means, providing further evidence that the representations underlying language and music processing are analogous

Further, the results mimic those of M^{c}Lennan and Luce (2005) in their slower condition in which participants performed a hard lexical decision task. In particular, instrument specificity effects emerged presumably because processing was relatively slow given the task was intentionally designed to be analogous to a hard lexical decision task. In other words, when the instrument matched in the prime and target blocks, reaction times were faster than when the instruments mismatched.

Vitevitch and Donoso (2011) also supported the time-course hypothesis by demonstrating how detection in the change of talker may be used to determine processing of indexical information in spoken word recognition. Results found listeners were "deaf" to a change in talkers (listeners failed to notice the change in talkers half way through the experiment) when completing an easy lexical decision task. Comparatively, listeners were more likely to notice the change in talkers when completing a hard lexical decision task.

A study examined within talker variation with emotional tone of voice (Krestar & McLennan, 2013). Krestar and McLennan (2013) chose sad and frightened emotional tones of voice because they were distinctive from one another (Sobin & Alpert, 1999). The study followed the same paradigm as McLennan and Luce (2005) and found results that were consistent with the time-course hypothesis. In both the match and mismatch conditions, emotional tone of voice produced similar reaction times in the easy lexical decision task, however in the hard lexical decision task the mismatched condition produced longer reaction times when compared to the match condition for emotional tone of voice.

There has been additional research, which has provided challenges - or exceptions - to the time-course hypothesis. First, Maibauer, Markis, Newell, and McLennan (2013) demonstrated attention might also be a factor in whether listeners use episodic or abstract representations when the time-course hypothesis was constructed with listeners hearing famous talkers and compared to non-famous talkers. Contrary to past studies talker effects emerged when the listener were performing/responding relatively quickly. These results were accounted for by theorizing that participants paid more attention to the spoken word spoken by famous talkers. These findings suggest that episodic representations are activated when processing a stimulus that requires greater attention, even when processing is quick.

In a separate study, Theodore and Blumstein, 2011 found talker effects emerged when participants were explicitly instructed to pay close attention to the talker even when the talkers were not famous talkers (Maibauer et al., 2013). Also, Tuft, McLennan, and Krestar (2016) conducted a relevant study with taboo words revealed taboo words facilitated processing and caused responses to be faster and more accurate than when neutral words were presented. It is interesting to note that all three reports found that attention in addition to (or instead of) processing speed also play a role in activating episodic representations. Finally, despite these challenges (see also, Papesh, Goldinger, & Hout, 2016), Incera, Krestar, McLennan, and González (2016) recently demonstrated that work with bilinguals processing in their first (fast) or second (slower) languages is consistent with the time-course hypothesis. In conclusion, future research should consider examining the easy task in the time-course hypothesis (McLennan & Luce, 2005).

An important finding from this research is the melody-based decision task. The melody task is a novel task that can be used in future research when comparing language and music. Additionally, given the methodology and results future research real instruments should be considered instead of synthesized instruments on Final 2009 for a more accurate understanding of how music and language can be compared especially in terms of "talker" and gender of instrument.

Future research should explore modalities moving further away from linguistic based music similar to the work of González and McLennan (2007), which studied hemispheric differences of indexical specificity effects in spoken word recognition using a lexical decision task with the use of long-term repetition-priming paradigm. González and McLennan (2007) results suggested that specificity effects affect the perception of spoken words differently in the right and left hemispheres. Due to these findings future research on environmental sounds, and non-linguistic vocalizations would extend the current research.

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APPENDICES

APPENDIX A
(Stimuli List)

Song	Composer
Toccata and Fugue in D minor (opening)	J S Bach
Symphony No. 5 in C minor (opening)	L v Beethoven
Symphony No. 9 in D minor (Ode to Joy)	L v Beethoven
Row Row Row Your Boat	trad.
Canon in D (the running notes part)	J Pachelbel
*Ten Little Indians	trad.
Für Elise (opening)	L v Beethoven
Wedding March (main theme)	F Mendelssohn
William Tell Overture (finale)	G Rossini
Star Wars (main anthem)	J Williams
Pirates of the Caribbean - He's A Pirate (opening theme)	H Zimmer
Mission Impossible Theme (opening theme)	L Schifrin
Twinkle Twinkle Little Star	trad.
*Lord of the Rings - Concerning Hobbits (opening theme)	H Shore
Mary Had a Little Lamb	trad.
If You're Happy and You Know It	trad.
When the Saints Go Marching	trad.
We Wish You a Merry Christmas	trad.

* Indicates songs used in practice for all conditions

APPENDIX B

(Participant Consent Form)

PARTICIPANT CONSENT FORM: SONG PERCEPTION
EMILY E. ZETZER, GRADUATE STUDENT, E.ZETZER@VIKES.CSUOHIO.EDU
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(216) 687-3834
CLEVELAND STATE UNIVERSITY: DEPARTMENT OF PSYCHOLOGY

This research project is being conducted as part of Emily Zetzer's Master's Thesis under the supervision of Dr. M[c]Lennan.

"I agree to participate in an experiment in which I will hear 'intact' songs and 'distorted' songs over headphones. I agree to respond to these 'intact' songs /'distorted' songs by pressing buttons on a button box or keys on a keyboard. I understand I will be asked to fill out questionnaires. I agree to respond to these questionnaires by writing or typing my answers. I understand my identity will be kept confidential at all times. That means my name will not be attached to my data. Instead, I will be assigned a code. I understand the file linking my name to my code will be kept in a separate filing cabinet in a locked storage room. I understand my consent form and other paperwork will be kept on file for three years after the end the project.

I fully understand this experiment. I understand I may ask questions at any time. I understand my participation will be no longer than one half hour. I understand I will receive .5 credit of research participation for my participation. I am also aware that I may refuse to continue the experiment at any time without loss of credit.

I understand participation in this experiment involves no more risk than I would encounter in daily life when hearing songs, pressing buttons and typing on a keyboard.

I understand the purpose of this research is to add knowledge in psychology. I understand there may be several indirect benefits of this study. However, there are no direct benefits other than receiving .5 credit of research participation."

Thank you!

"I am 18 years or older, and I understand this consent form. I understand that if I have any questions about my rights as a research subject, I can contact the Cleveland State University Institutional Review Board at (216) 687-3630."

_______________________________ _______________________

Signature of Participant *Date*

____

Name of Participant (PLEASE PRINT) *E-mail address* *Telephone Number*

_______________________________ _______________________

Signature of Researcher *Date*

APPENDIX C
(Demographics)

PARTICIPANT INFORMATION FORM
PAGE 1
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FOR LRL USE:
Room #________________
Participant #____________
_____ (credits) OR $_____
Experiment ____________
Date _________________
Experimenter ___________

Please fill in the following information:

Name: ____

*Address: ____
____

E-mail address (es): ____
____

Telephone Number: ______________ Cell Phone Number: __________________

Date of Birth: __________________________ Place of birth (City):___________________

Gender: ___________ Major: ______________________________

Place of Longest Residence (City): _________________________________

First language spoken: ____

Are you (circle one): right-handed left-handed ambidextrous

What languages do you speak fluently? ____________________________________

Would you like to be added to (or remain on) our "Paid Participants Database" so that we can notify you in the future of paid experiments for which you are eligible to participate?
____

**Note: If you would prefer not to provide your full address and phone number(s), you may simply provide your zip code. Thank you.*

PARTICIPANT INFORMATION FORM
PAGE 2
EMILY E. ZETZER, GRADUATE STUDENT: E.ZETZER@CSUOHIO.EDU
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FOR LRL USE:
Room #_______________
Participant #____________
_____ (credits) OR $_____
Experiment _____________
Date _________
Experimenter ___________

Please note that your responses to the following questions will *not* be directly linked to your name. As with any part of your experience as a research participant in our study, please feel free to ask the experimenter if you have any questions. Thank you.

Have you ever had a hearing or speech disorder?

(circle one) YES NO

If yes, please explain: ____

Have you ever had a visual or reading disorder (other than glasses/contacts)?

(circle one) YES NO

If yes, please explain: ____

Have you ever been diagnosed with Attention Deficit Disorder (ADD) or Attention Deficit Hyperactivity Disorder (ADHD)?

(circle one) YES NO

If yes, please explain: ____

APPENDIX D

(Edinburgh Handedness Inventory [modified and completed on computer])

You can further help us by providing answers to the following questions. There are no right or wrong answers. Please indicate your preferences in the use of hands in the following activities by answering L for Left hand OR R for Right hand, OR X for No preference. After answering L, R, or X, please answer whether or not you ever use the other hand for each activity by typing Y for Yes OR N for No. Please answer all of the questions. If you have any questions, please ask the experimenter. Please type in your assigned ID number.

Which hand do you write with?
L) Left R) Right X) No Preference

Writing
Do you ever use the other hand?
Y for Yes OR N for No

Which hand do you draw with?
L) Left R) Right X) No Preference

Drawing
Do you ever use the other hand?
Y for Yes OR N for No

Which hand do you throw with?
L) Left R) Right X) No Preference

Throwing
Do you ever use the other hand?
Y for Yes OR N for No

Which hand do you use when using scissors?
L) Left R) Right X) No Preference

Scissors
Do you ever use the other hand?
Y for Yes OR N for No

Which hand do you put your toothbrush in?
L)Left R) Right X) No Preference

Toothbrush
Do you ever use the other hand?
Y for Yes OR N for No

Which hand do you use when using a knife without a fork?
L) Left R) Right X) No Preference

Knife
Do you ever use the other hand?
Y for Yes OR N for No

Which hand do you use when using a spoon?
L) Left R) Right X) No Preference

Spoon
Do you ever use the other hand?
Y for Yes OR N for No

Which hand is your upper hand when using a broom?
L) Left R) Right X) No Preference

Broom
Do you ever use the other hand?
Y for Yes OR N for No

Which hand do you use when striking a match?
L) Left R) Right X) No Preference

Striking a match
Do you ever use the other hand?
Y for Yes OR N for No

Which hand do you use when opening a lid to a box?
L) Left R) Right X) No Preference

Opening a lid to a box
Do you ever use the other hand?
Y for Yes OR N for No

Thank you! Please inform the researcher that you have completed this questionnaire.

APPENDIX E

(Race, Ethnicity and Gender Questionnaire [completed on computer])

Your gender is:

a.) Male
b.) Female
x.) Skip

Your ethnic background is:

a.) Hispanic or Latino
b.) Not Hispanic or Latino
x.) Skip

Your racial background is:

a.) American Indian/Alaska Native
b.) Native Hawaiian or Other Pacific Islander
c.) White
d.) Unknown
e.) Asian
f.) Black or African American
g.) More than One Race
x.) Skip

Thank you! Please inform the researcher that you have completed the questionnaire.

APPENDIX F
(Lexical 'Type' Song Decision Instructions)

Language Research Laboratory: Chester Building 249

Welcome to the Language Research Laboratory. We appreciate your helping us today.

In the study that you will be participating in today, you will hear "intact" intact songs and "distorted" versions of songs over headphones

We want you to decide as quickly but as accurately as possible if each item is an "intact" intact song OR a "distorted" version of a song by pressing one of the two appropriately labeled buttons on the response box in front of you.

A typical trial will proceed as follows: A Song will be presented over your headphones.

As quickly as you can, press the GREEN button on the right if you think the item is an "intact" intact song or the RED button on the left if you think the item is a "distorted" version of a song. Try to be as fast but as accurate as possible. As soon as you have responded, a new trial will begin.

Please HOLD the response box in your hands with your right thumb above the GREEN ("intact" song) button and your left thumb above the RED ("distorted" song) button.

We will begin with a brief practice phase to familiarize you with the experiment.
If you have any questions, please ask the experimenter now.

Let the experimenter know when you are ready to begin the experiment. Thank you.

APPENDIX G
(Math Test)

Language Research Laboratory
Mathematical Evaluation Test (MET)

Welcome to our research laboratory. We are attempting to determine the level of difficulty of certain math problems for another experiment in our laboratory. You can help us by completing the following problems as quickly but as accurately as possible. This is not a test of your intelligence or your math abilities. In fact, we will never associate your name with your answers. We are simply interested in determining which of the following problems are easy and which are difficult.

When the experimenter tells you to begin, turn the page and begin working on the problems. The experimenter will tell you when to stop working.

Thank you for helping us.

MET PART 1

1. $5387 \div 52 =$ ____________________

2. $585{,}975 \div 32 =$ ____________________

3. $7845.55 \times 77.99 =$ ____________________

4. $\left(\frac{77}{32}\right) + \left(\frac{895}{84}\right) =$ ____________________ (express answer as fraction)

MET PART 2

1. $4276 \div 41 =$ ____________________

2. $485{,}875 \div 22 =$ ____________________

3. $6835 \times 66 =$ ____________________

4. $\left(\frac{32}{77}\right) + \left(\frac{84}{895}\right) =$ ____________________ (express answer as fraction)

APPENDIX H

Post-Experiment Questionnaire (completed on computer)

You can further help us by providing answers to the following questions. There are no right or wrong answers. You may enter X as a skip at anytime for any question you may not wish to answer. We are simply interested in your experience in the experiment that you have just participated in and your musical experience.

If you have any questions, please ask the experimenter.

Please type in your assigned number.

Please rate each instrument as masculine or feminine on a scale of 1 to 10.

harp

Feminine 1 -- 2 -- 3 -- 4 -- 5 -- 7 -- 8 -- 9 -- 10 Masculine

Flute

Masculine 1 -- 2 -- 3 -- 4 -- 5 -- 7 -- 8 -- 9 -- 10 Feminine

Piccolo

Feminine 1 -- 2 -- 3 -- 4 -- 5 -- 7 -- 8 -- 9 -- 10 Masculine

Glockenspiel

Masculine 1 -- 2 -- 3 -- 4 -- 5 -- 7 -- 8 -- 9 -- 10 Feminine

Cello

Feminine 1 -- 2 -- 3 -- 4 -- 5 -- 7 -- 8 -- 9 -- 10 Masculine

Violin

Masculine 1 -- 2 -- 3 -- 4 -- 5 -- 7 -- 8 -- 9 -- 10 Feminine

Clarinet

Feminine 1 -- 2 -- 3 -- 4 -- 5 -- 7 -- 8 -- 9 -- 10 Masculine

Piano

Masculine 1 -- 2 -- 3 -- 4 -- 5 -- 7 -- 8 -- 9 -- 10 Feminine

French Horn

Feminine 1 -- 2 -- 3 -- 4 -- 5 -- 7 -- 8 -- 9 -- 10 Masculine

Oboe

Masculine 1 -- 2 -- 3 -- 4 -- 5 -- 7 -- 8 -- 9 -- 10 Feminine

Guitar

Feminine 1 -- 2 -- 3 -- 4 -- 5 -- 7 -- 8 -- 9 -- 10 Masculine

Cymbal

Masculine 1 -- 2 -- 3 -- 4 -- 5 -- 7 -- 8 -- 9 -- 10 Feminine

Saxophone

Feminine 1 -- 2 -- 3 -- 4 -- 5 -- 7 -- 8 -- 9 -- 10 Masculine

Bass Drum

Masculine 1 -- 2 -- 3 -- 4 -- 5 -- 7 -- 8 -- 9 -- 10 Feminine

trumpet

Feminine 1 -- 2 -- 3 -- 4 -- 5 -- 7 -- 8 -- 9 -- 10 Masculine

String Bass

Masculine 1 -- 2 -- 3 -- 4 -- 5 -- 7 -- 8 -- 9 -- 10 Feminine

Tuba

Feminine 1 -- 2 -- 3 -- 4 -- 5 -- 7 -- 8 -- 9 -- 10 Masculine

Choral Conductor

Masculine 1 -- 2 -- 3 -- 4 -- 5 -- 7 -- 8 -- 9 -- 10 Feminine

Instrument Conductor

Feminine 1 -- 2 -- 3 -- 4 -- 5 -- 7 -- 8 -- 9 -- 10 Masculine

Are you a music major?

1.) Yes

2.) No

X.) Not Applicable

Are you a music minor?

1.) Yes

2.) No

X.) Not Applicable

On average, approximately how many hours per day do you listen to music?

1.) 0-1 hrs

2.) 1-5 hrs

3.) 5-10 hrs

4.) 10-15 hrs

5.) 15+ hrs

X.) Not Applicable

Have you ever been to a concert?

1.) Yes

2.) No

X.) Not Applicable

Have you ever been in a concert?

1.) Yes

2.) No

X.) Not Applicable

Do you play any musical instrument(s)?

1.) 0

2.) 1

3.) 2

4.) 3

5.) 4

6.) 5+

X.) Not Applicable

How long have you played an instrument?

1.) 1-6months

2.) 6-12months

3.) 1-4 years

4.) 4-8 years

5.) 8-12 years

6.) 12-16 years

7.) 16+ years

X.) Not Applicable

Were you in concert band?

1.) Yes

2.) No

X.) Not Applicable

If yes, specific number of years

1.) 1-6months

2.) 6-12months

3.) 1-4 years

4.) 4-8 years

5.) 8-12 years

6.) 12-16 years

7.) 16+ years

X.) Not Applicable

Were you in marching band?

1.) Yes

2.) No

X.) Not Applicable

If yes, specific number of years

1.) 1-6months

2.) 6-12months

3.) 1-4 years

4.) 4-8 years

5.) 8-12 years

6.) 12-16 years

7.) 16+ years

X.) Not Applicable

Were you in any form of a Choir?

1.) Yes

2.) No

X.) Not Applicable

If yes, specific number of years

1.) 1-6months

2.) 6-12months

3.) 1-4 years

4.) 4-8 years

5.) 8-12 years

6.) 12-16 years

7.) 16+ years

X.) Not Applicable

Were you in orchestra?

1.) Yes

2.) No

X.) Not Applicable

If yes, specific number of years

1.) 1-6months

2.) 6-12months

3.) 1-4 years

4.) 4-8 years

5.) 8-12 years

6.) 12-16 years

7.) 16+ years

X.) Not Applicable

Please rate yourself on your own musical expertise

Inexperienced 1 -- 2 -- 3 -- 4 -- 5 -- 7 -- 8 -- 9 -- 10 Expert

Please list all instruments you play/have played? (You may indicate not applicable)

Did you have difficulty deciding weather a stimuli was an ‘intact’ song or 'distorted' song during the experiment? Please explain.

What do you think was the purpose of this experiment?

Do you have any general comments or observations about the experiment?

Thank you!

Please inform the researcher that you have completed this questionnaire

APPENDIX I

(Debriefing Form)

DEBRIEFING FORM

EMILY E. ZETZER, GRADUATE STUDENT, E.ZETZER@VIKES.CSUOHIO.EDU
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Thank you for your participation! Dr. McLennan's work demonstrating perceptual benefits during spoken word recognition was the basis for the study you just participated in. Specifically, under some conditions, when information contained in the speech signal (such as the talker) matches from one time to another participants are more efficient at recognizing spoken words. The current experiment investigates if song identification ('intact' song / 'distorted' song) demonstrates similar findings found in spoken word recognition. Instead of the talker being the same or different, in the current experiment the instrument playing particular songs was either the same or different.

Any data you have provided will be kept confidential. Any information you provided relating to impairments will not be tied directly to your name. If you have friends participating in experiments in this laboratory, please keep the purpose of this experiment confidential in case we ask them to participate in the future.

If you have any questions about your rights as a research participant, you can contact the Cleveland State University Institutional Review Board at (216) 687-3630.