AFFECTIVE PRIMING OF MUSIC AND WORDS

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By

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Abstract

In recent times the relationship between language and music has garnered substantial interest (Patel, 2008). The present thesis used an affective priming paradigm, in which musical sequences and words were categorized as happy or sad, to determine whether lexical and musical information of matched affect could act as effective primes (stimulus congruency). Experiment 1 was a replication of previously reported congruency effects using auditory presentation of lexical stimuli. In Experiment 2, two words, two short musical sequences or one of each were presented auditorily and participants responded by categorizing the emotional valence of the second item as happy or sad. Experiment 3 examined the extent to which affective properties of words and musical chords have an impact on judgments in a semantic decision task. Participants responded to the semantic properties of the second item (i.e., whether it was a word or a chord, or neither). In all of the experiments, affective congruency effects were observed, suggesting that affective properties can influence the priming of music and words when they are presented together. However, although similarities were found between affective priming of words and music, there were differences. First, responses to the musical stimuli were slower than those to the word stimuli. Second, in some conditions contrast, rather than congruency was observed. These studies are the first to explore word-music affective priming. In addition, the research expands the existing knowledge of affective priming of lexical and musical stimuli and provides evidence of similarities and differences between musical and lexical processing.

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Affective Priming of Music and Words

Music is a rich and diverse art form that possesses a capacity to influence one's emotional experiences. Like language, music is ubiquitous and serves as one of the most substantial communicative measures in human culture, naturally inviting comparison between the two domains (Patel, 2008, p. 3). Common elements of music are pitch (which governs melody and harmony), rhythm (and its associated concepts tempo, meter, and articulation), dynamics, and the sonic qualities of timbre and texture. These elements interact to form never-ending combinations of musical compositions that are created by seasoned composers or performers who alter these elements as an artistic endeavor (Music, 2005). The internal relation between music and emotion has been under investigation for many years (see Meyer, 1956) and in recent times the interrelation between language and music has gained substantial interest (Sollberger, Reber & Eckstein, 2003). From the vantage point of modern cognitive science, music-language relations have barely begun to be explored (Patel, 2008, p. 3) and it is hoped that this thesis will contribute to this newly expanding area of research.

The present studies used an affective priming paradigm in which target words and/or musical sequences were chosen to reflect happiness or sadness (Experiments 1 and 2). The match in valence between the prime and target was manipulated. Experiment 3 indirectly explored affective priming through a semantic judgment task in which real and artificial musical and lexical items were categorized as word/chord or neither. Again the match in valence between the prime and the target for the meaningful stimuli was varied. The goals of this thesis are as follows: 1) to review the affective priming research in the lexical and musical domains, both separately and jointly; 2) to determine whether words and musical sequences of matched affect can prime one another (stimulus congruency); 3) to determine whether emotional congruency or hedonic contrast between stimuli plays a role in priming in this situation; and 4) to determine whether affective properties of words, nonwords, musical notes and musical chords influence judgments in a task in which they are not strictly relevant; a semantic decision task. To date, these goals have yet to be fully explored. For example, there has yet to be a priming experiment in which judgments of musical stimuli are primed by words (there has been, however, a study in which judgments of words were primed by musical stimuli; Sollberger et al., 2003). In addition, there has yet to be a study in which lexical stimuli (i.e., words) and music stimuli (i.e., chords or musical sequences) have been examined both emotionally and semantically within a semantic decision task. Carrying out such experiments will give insight into the relationship between musical and lexical items in both affective priming and semantic priming tasks. It will be argued that a clear distinction should be made between semantic and emotional judgments in semantic decision tasks and that deep, contextual elements of music possess the ability to interact with and influence word processing on an emotional level. The findings presented here arising from exploring cross-domain associations add to basic research in this field that helps to explain the relationship between music and language at a fundamental level. The experiments will address the challenges of deriving comparisons in this cross-domain investigation through the use of an affective priming paradigm and a semantic judgment task.

Priming

Priming occurs when an earlier stimulus (a prime) influences the response to a later stimulus (a target). Following a prime stimulus, participants are usually asked to evaluate (e.g., decide YES or NO via forced choice tasks) or to pronounce the target stimulus. A typical finding is that responses are faster and more accurate when the prime and target are semantically related. Typical priming experiments involve pairings of words that possess related perceptual (e.g., PITCH/WITCH), semantic (e.g., SQUIRREL/NUT), emotional (e.g., ROSE/LOVE) and unrelated (e.g., BUTTER/ROCK) properties. Responses (i.e., button presses) to related word pairs are faster and more accurate than responses to unrelated pairs; this is referred to as a priming effect (Sumner & Samuel, 2007). An assumption in much of the priming research is that the first stimulus activates parts of particular representations or associations in memory. Hence, the representation of the second stimulus is already partially activated when it is encountered, thus improving performance on the task (Sumner & Samuel, 2007).

Types of Verbal Priming

There are three main types of verbal priming: repetition priming, perceptual priming, and semantic or conceptual priming. Repetition priming refers to the finding that an initial presentation of a stimulus influences the way in which an individual will respond to that same stimulus when it is presented at a later time (e.g., presenting the word *floor* and then presenting it again after some time). The response to a specific item that has been encountered recently (a word, for example) is faster and more accurate compared to another item that has not. Perceptual priming refers to effects of the form or structure of the prime stimulus on processing of the target stimulus (e.g., *lime* presented before *time*), and with a greater match between the prime and target, such as rhyming, there is an enhanced response to the target. Semantic (conceptual) priming refers to the effects of the meaning of the prime stimulus on the processing of the target stimulus and thus, the response to the target is enhanced due to similarity in semantic properties between the prime and target (Vaidya, Gabrieli, Monti, Tinklenburg & Yesevage, 1999). With regard to the current research, the primary interest lies in semantic or conceptual priming, in which meaningful relationships between the prime and target facilitate responses. Henceforth, the term *semantic priming* will be used rather than *conceptual priming*, as both terms are, for the purposes of this thesis, interchangeable.

Priming of linguistic or verbal information has been tested in a variety of paradigms (Fischler & Bloom, 1980; Meyer & Schvaneveldt, 1971; Stanovich & West, 1979). The literature surrounding semantic priming and affective priming in language will now be discussed followed by a review of the music priming literature. The term "congruency" will be introduced and explanations of priming will be outlined. Then, the research on affective priming combining the language and music domains as well as the challenges encountered when attempting to merge the areas will be considered. The literature on semantic versus evaluative categorization will be briefly examined. The review will be completed by outlining the present research hypotheses.

Semantic Priming

Semantic priming has been extensively examined (Duscherer & Holender, 2003; Fischler & Bloom, 1980; Meyer & Schvaneveldt, 1971; Stanovich & West, 1979). Verbal priming tasks typically use forced choice lexical judgments in which participants are shown a string of letters and are asked to determine whether the string is a legal word (lexical decision). It has been consistently shown that in a lexical decision task the processing of a target word (e.g., *steak*) is faster and more accurate when it follows a semantically related prime word (*e.g., food*) than when it follows an unrelated prime word (e.g., *car*; Meyer & Schvaneveldt, 1971). Semantic priming also occurs in short contexts (i.e., word pairs), full sentences, and regular discourse (Fischler & Bloom, 1980; Stanovich & West, 1979). Explanations for semantic priming effects involve prelexical influences, such as the perceiver's semantic knowledge (Duscherer & Holender, 2003) and postlexical influences tied to participants' strategies with the experimental task and situation (Klinger, Burton & Pitts, 2000).

It is frequently assumed that in addition to determining the denotative meaning of an incoming stimulus, people spontaneously evaluate incoming stimuli as being pleasant or unpleasant, liked or disliked, good or bad. That is, both the literal meaning and suggested or implied characteristics are typically processed when evaluating incoming stimuli. Evaluative processes of this kind play a central role in current theories of emotion and attitude (Harrison, 1986; Juslin & Sloboda, 2010). One avenue to studying the evaluative response has been through the use of the affective priming paradigm. An affective priming task investigates whether the affective properties of a first stimulus (the prime) influences the processing of subsequent stimuli.

Emotion and Affect

The terms *emotion* and *affect* require clarification here, as there are subtle differences in their usage across the literature; specifically differences within the lexical priming and music priming literatures (Sollberger et al., 2003). In addition, distinguishing between emotion and affect is important in comprehending the music cognition literature. According to the Diagnostic and Statistical Manual of Mental Disorders-IV-TR (American Psychiatric Association, 2000, p. 819), *affect* is a "pattern of observable behaviors that is the expression of a subjectively experienced feeling state (emotion)," with common examples listed as sadness, elation and anger. Thus, *emotion* is a state of feeling and affect is the outward appearance of the emotion state. Emotion and affect are defined as per Panksepp's (2000) account in that emotion is considered to be an umbrella term for all of the behavioral, expressive, cognitive and physiological changes that occur within an individual when a stimulus is perceived, whereas affect is considered to be the conscious experience of an emotion. Affect indicates the level of pleasantness or unpleasantness that one experiences when presented with a stimulus, as affect is the observable action caused by the emotion state. Thus pleasant stimuli can be considered to be emotionally positive while unpleasant stimuli can be considered emotionally negative both of which result in an affective response from the observer.

In the past, several theorists (e.g., Lazarus, 1982) considered affect to be post-cognitive. Affect was thought to be activated only after the cognitive processing of the incoming information was completed. In this framework, the affective reaction (i.e., liking or disliking) was based on a prior evaluative event whereby the information was encoded, identified and examined for its value. Some scholars now believe that affect co-occurs with cognitive processing, with thoughts being produced by initial emotional responses, and further affect being produced by the thoughts (Lerner & Keltner, 2000). Given that the present experiments require participants to make a conscious decision about the valence of the stimuli, rather than measuring an emotional response, the term 'affect' will be used when describing the data rather than 'emotion'.

Affective Priming

Explanations of affective priming have traditionally been adapted from the literature involving semantic priming. For instance, in affective priming an *emotional relationship* between the prime and target will facilitate target responding, which is similar to outcomes found in semantic priming when a *meaningful relationship* enables faster responses (Klauer, 1998). Affective priming tasks generally consist of presenting a stimulus that is associated with happiness or sadness (or perhaps pleasant or unpleasant) and following it with a congruent (i.e., prime and target are affectively similar) or incongruent (i.e., prime and target are affectively dissimilar) stimulus. In a 1986 study, Fazio, Sanbonmatsu, Powell and Kardes found that participants required less time to judge the affective connotation of a target stimulus (e.g., the word "ugly") after the presentation of an affectively related prime stimulus (e.g., the word "hate") than after the presentation of an unrelated prime stimulus (e.g., the word "flower"). Based on this and subsequent research, Fazio (2001) suggested that the priming effect was based on fast-acting processes that did not depend upon the conscious identification of the primes, nor on the allocation of processing resources. This finding suggests that emotional valence can be considered a characteristic of relatedness between the prime and the target, whereby a similar emotional valence between prime and target can act as a priming dimension. The degree of similarity in affective meaning between the prime and target stimuli influenced the time it took to respond to the target. The more similar the affective relationship between the two items, the less time it took to make a judgment on the affective dimension of the target item; this is called *affective congruency*.

Music Priming

Tonality refers to the cognitive organization of musical pitch associated with the major-minor (diatonic) scale system of Western-European music. The system of relations has been studied by cognitive psychologists extensively over the last thee decades beginning with the seminal work of Krumhansl and Shepard (1979), which revealed a hierarchical organization of the 12 chromatic tones of the musical octave. Further details are provided in Appendix A, although the complete discussion is outside the bounds of this thesis.

In the music priming paradigm, participants are required to make judgments about the perceptual features of the target chord, such as intonation judgments (Bharucha & Stoeckig, 1987; Bigand, Poulin, Tillmann, Madurell & D'Adamo, 2003), phoneme identification for sung music (Bigand, Tillmann, Poulin, D'Adamo, & Madurell, 2001), and timbre discrimination (Tillmann, Bigand, Escoffier & Lalitte, 2006). The primes in these cases either share structural features (e.g., the same tonality) or have unrelated structural features. In addition, participants may also be asked to make semantic judgments relating to tonal relationships between the stimuli; for instance, making a consonance/dissonance judgment of a target chord in reference to a priming tonal scale. An early study that investigated chord relationships within the music priming paradigm measured the time to discriminate between a target chord that was related to a preceding prime chord and a mistuned foil (Bharucha & Stoeckig, 1987). Related targets (i.e. tuned or non-foil items) were processed more quickly and were perceived to be more consonant than unrelated targets, suggesting that music processing involves the automatic, unconscious activation of evaluative knowledge that can be applied to incoming stimuli and acted upon instantaneously. Individuals are thus able to discern incoming musical information very rapidly and provide a similar activation process to that of language (Bharucha & Stoeckig, 1987). The priming paradigm has also provided evidence for the influence of tonal stability on the processing speed of musical events, notably with facilitated processing for tonic targets over subdominant targets (Bigand & Pineau, 1997; Bigand et al., 2003). An advantage of the priming paradigm is that it allows for the investigation of listeners' implicit knowledge of music and provides insight into an individual's ability to process and evaluate music.

Another area in music priming research involves harmony. Harmony is an important parameter within tonality and it involves the simultaneous combination of sounded pitches, called chords (Snyder, 2000, p. 196). Harmony refers to structural regularities between chords in Western tonal music. A hierarchy of functional importance exists between chords: the tonic chord is at the top of the hierarchy and represents the most referential event of a key; it is followed by the dominant chord, the subdominant chord, other in-key chords, and finally out-of-key chords. The harmonic priming paradigm, whereby harmonically related items act as better primes than non-harmonically related primes, has consistently shown that listeners without formal musical training can acquire implicit knowledge of tonal harmony by mere exposure to music in everyday life (Bigand & Poulin-Charronnat, 2006; Tillmann, Bharucha, & Bigand, 2000).

In these types of studies the target chords are evaluated based on whether they are harmonically related (i.e., in the same key) to the prime. The participant is typically asked make a binary decision as to whether or not a target note "fits" within the given context (e.g., a melodic sequence). Primes and targets can be harmonically related to varying degrees (as there are a variety of chords within a key) and it is assumed that the more harmonically related a prime and chord, the more consistent a response that the note fits within the melodic context. Two pairs of chords can be both harmonically related, but one pair can be also more harmonically related than another pair.

Harmonic priming studies have also shown that within a musical context, harmonic elements and the tonal hierarchy can influence target chord processing. Bigand, Madurell, Tillmann and Pineau (1999) trained participants to differentiate between dissonant and consonant chords by asking them to make a consonant-dissonant judgment as quickly as possible. Consonant chords refer to chords that consist of harmonically related tones while dissonant chords consist of unrelated tones and violate rules of Western tonal music. The participants were asked to listen to eight chords of a sequence and to make a quick consonant-dissonant judgment for the eighth chord by pressing a key. The chord sequences differed in several aspects related to the melodic contour of the upper and bass voices, the sequential order of the chords and the voicing (the specific pitch height of the component tones). Given these variations, the four chord sequences all sounded different from each other. Participants were informed that all of the sequences contained eight chords and that half would finish with a dissonant chord and half with a consonant one. Judgments were facilitated when consonant chords were presented as the target item. The authors argued that priming effects resulted from activations spreading via a schematic knowledge of Western harmony. This knowledge was established in both musicians and untrained listeners.

Harmonic priming studies using tonal contexts have provided evidence that listeners perceive the difference between tonic and out-of-key chords (e.g., Tillmann, Bigand, & Pineau, 1998) and the difference between tonic and subdominant chords (e.g., Bigand et al., 1999). Subsequent research by Tillman and Bigand (2001) extended these findings by comparing tonal sequences ending either on strongly related tonic targets or related dominant targets with sequences without a tonal center (i.e., baseline sequences). The task involved participants making judgments as quickly and accurately as possible whether an isolated chord or the last chord of the chord sequence was acoustically consonant or dissonant by pressing one of two keys. These data showed that listeners perceived even finer differences in harmonic functions, as reflected by the facilitated processing of tonic targets over dominant targets. Additionally, response time patterns reflected the ranking of tonal hierarchy described by music theory, with the tonic being at the top of the hierarchy leading to the fastest response times, followed by the dominant and then the subdominant. The findings indicated that listeners implicitly understand fine differences in tonal stability and confirm the special status of the tonic being the most expected chord at the end of a tonal context. In addition, the global context effects (i.e., the effects occurring as a result of the relationships between tones and chords played simultaneously and sequentially) suggest that harmonic priming involves higher level harmonic structure found not only from chord to chord, but within each chord separately (Bigand & Pineau, 1997; Bigand et al., 1999; Tillman et al., 1998; Tillman & Bigand, 2001). The preceding research demonstrates a natural ability to understand harmony and how music contains elements that are processed regardless of exposure.

A study by Poulin-Charronnat, Bigand, Madurell and Peereman (2005) built on the harmonic priming research to explore the effect of musical harmony on the processing of words in vocal music. Eight-chord sung sentences were presented with the last chord being either semantically related or semantically unrelated to the global context and the target word was sung on a chord of varying stability to the tonic. In a lexical decision task (i.e, was the target a word or not?), a significant interaction was found between semantic and harmonic relatedness suggesting that music plays a role in facilitating semantic priming in vocal music. These findings are relevant to the current thesis, as they demonstrate cross-domain influence between musical harmony and semantic contexts in lexical phrasing.

Semantic information in language and music differs greatly in its inherent structures (Tillman & Bigand, 2001). Further, semantic information serves a different role in language in comparison to music. With music, semantic information refers to that which is conceptually sound – what notes "fit in" with other notes. Semantic information in language, however, is very different in that semantic information is arbitrary and largely depends on past experience (Bigand et al., 1999); if an individual does not associate the words "dog" and "leash" with each other, then any meaningful relationship between the two is lost. Music is much more robust in that, within Western tonal notation, there is a set degree of relatedness between music notes. To explore in detail the relationship of music and language then, a common dimension must be found. The affective dimension is suitable for this comparison, as both music and language possess affective properties and evoke pleasantness and unpleasantness. A similar response (i.e., the target is happy) can be made in both domains using the affective dimension (Klauer, 1998). If music and words invoke similar affective responses, an increased understanding of musical influence on emotion may be obtained by observing ways in which chords and words influence each other. Having examined past data in priming research, the next section examines theoretical considerations of priming activation and provides further reasoning behind facilitated activations in the affective priming paradigm. Congruency effects will be examined as well as expectancy mechanisms.

Congruency

The prime stimulus and the target stimulus may possess some relation with each other that makes their relationship congruent (e.g., enjoy-love, are emotionally 'happy' words) or incongruent (e.g., war-love, possess different emotional valences). Response latencies in lexical decision tasks tend to be shorter when the two items are congruent. This shortened latency is known as a congruency effect and has been consistently observed in the literature (Fazio et al., 1986; Fazio, 2001). In lexical priming studies, the congruency concerns the detected relation between words (i.e., YES, they are related vs. NO they are not related) and the requested (binary) response (i.e., YES, the target is a word vs. NO, it is not a word). A congruency relation speeds up positive lexical responses for related trials (i.e., YES a word and YES related) and slows down positive responses for unrelated trials (i.e., YES a word, but NO unrelated). Congruency effects result from an overlap between the response types in the experimental task and the contextual manipulation between prime and target; they may thus occur in the music domain as well. With music stimuli, increasingly related prime and target stimuli facilitate responses just as with lexical stimuli; however, there are various types of relationships between tones. The majority of music priming studies have based relatedness on tonality, although timbral features (Tillmann et al., 2006) as well as intensity (amplitude; Bigand et al, 1999).

Most music priming research has used the sensory consonance task, whereby consonant and dissonant tones are used as primes to consonant or dissonant targets. Individuals are asked to decide whether the target tone is in tune or out of tune. The results typically show that consonant targets are processed faster with consonant than with dissonant primes (Tillmann et al., 2006). Such a task may confound true priming effects, as the results may occur due in part to activation of musical knowledge. A striking observation, however, is that priming effects are most of the time modulated by the target type. In-tune (consonant) targets are processed faster and more accurately when they are related to the prime context. This priming effect tends to be less pronounced for the out-of-tune (dissonant) targets. More troublesome, in some experiments comparing related to unrelated primes, priming effects for out-of-tune (dissonant) targets are even reversed, leading to crossover interactions between target type and musical relatedness (Bharucha & Stoeckig, 1987; Tillmann et al., 1998). In these cases, the prime's influence is reflected in a response bias (i.e., a tendency to judge chords to be in-tune when musically related to the prime and out-of-tune when unrelated) and in an increased sensitivity to the chord's intonation (i.e., shorter response times for in-tune targets when related and for out-of-tune targets when unrelated). This interactive effect observed between target type and musical relatedness suggests that musical priming effects may result from congruency effects similar to those described in semantic priming studies where related prime and targets observed faster response times (e.g., Duscherer & Holender, 2003; Holender, 1992).

The Tillmann et al. (2006) study provided evidence that musical priming effects cannot be reduced to the sole influence of congruency effects. This point was demonstrated by use of a timbre discrimination task (e.g., determining whether the tone was played on a piano or violin), in which participants were trained to differentiate between the timbres of 24 single chords and four-chord sequences and were later asked to judge the timbre (e.g., piano or violin) of the target with chord sequences only. Until this study was published, most musical priming studies used sensory consonance judgments that involved a YES or NO response (the chord is consonant or not), and these response possibilities were likely to overlap with the factor of interest (YES or NO musical relatedness between prime and target). Interpretation of the data in terms of congruency effects was notably based on the previously reported interactions between target type and musical relatedness (e.g., Bharucha & Stoeckig, 1987). The use of a timbre discrimination task had the advantage of avoiding YES or NO responses. Chord processing was facilitated when the target was related (in terms of its timbre) to the prime context in comparison to when it was less related. In addition, the strength of the relatedness effect was similar for the two target timbres suggesting that congruency effects did not interfere with the effect of musical context. These findings give rise to new research questions within the affective priming paradigm: Will robust congruency effects be observed when musical sequences serve as primes and targets? Will emotional congruency effects be observed in a musical sequence priming task? Will the effects remain present when sequences and words act as primes and targets?

Explanations of Priming

Spreading Activation

Several proposed theoretical frameworks have been developed to account for congruency effects. Early studies of spreading activation by Collins and Loftus (1975) outlined several assumptions of semantic activation. When a concept is processed (or stimulated), activation spreads out along the paths of the network in a decreasing gradient. The decrease is inversely proportional to the accessibility or strength of the links in the path. Thus, activation is like a signal from a source that is attenuated as it travels outward. The longer a concept is continuously processed (either by reading, hearing, or rehearsing it), the longer activation is released from the node of the concept at a fixed rate. In addition, only one concept can be actively processed at a time (a limitation imposed by the serial nature of the human central process). This assumption implies that activation can only start out at one node at a time, but can continue in parallel from other nodes that are encountered as activation spreads out from the node of origin.

The semantic (conceptual) network is organized along the lines of semantic similarity. The more properties two concepts have in common, the more links there are between the two nodes via these properties and the more closely related are the concepts. This assumption leads to the implication that different vehicles or different colors will all be highly interlinked through their common properties. What is also implied is that red things (e.g., fire engines, cherries, sunsets, and roses), for instance, are not closely interlinked, despite the one property they have in common. In these terms, semantic relatedness is based on an aggregate of the interconnections between two concepts. In order to decide whether or not a concept matches another concept, enough evidence must be collected to exceed either a positive or a negative criterion. The evidence consists of various kinds of intersections that are found during the memory search.

Bower (1991) and Fazio et al. (1986) proposed similar evaluative-response mechanisms that can be understood in terms of automatic spreading activation. Roughly speaking, the evaluations of the prime and target stimuli are activated very quickly and automatically upon their presentations. If prime and target are evaluated differently, the evaluative response to the prime interferes with that of the target, whereas if prime and target agree in evaluation, the evaluative response to the target is augmented. Affective priming is thereby expected for any kind of task that is based on the evaluative response to the target.

The same authors also admit the possibility of a spreading-activation account at the stimulus-level. According to this account, activation of the node of the priming word spreads to nodes linked to it directly or via intermediate nodes in a vast semantic network (Hermans, De Houwer & Eelen, 1996), thereby reducing the time required for the activation levels to exceed recognition threshold in the activated nodes. If the spread of activation is assumed to be unlimited in capacity (Posner & Snyder, 1975) and if it is assumed that nodes of words with equal affective connotation are all linked directly or via intermediate nodes (Bower, 1991), affective priming is obtained. Whether an evaluative-response mechanism or stimulus-level account is proposed, spreading activation is assumed to occur without a person's awareness or intent, and to be fast-acting (Neely, 1991; Posner & Snyder, 1975).

Several authors have argued against spreading-activation explanations at the stimulus-level on theoretical grounds (Bargh, Chaiken, Raymond, & Hymes, 1996). A primary issue is the assumption of unlimited capacity in spreading activation. Since the number of positive and negative concepts in memory is large, a limited quantity of activation would run out in a so-called cue overload or fanning effect (Anderson & Bower, 1973) and fail to produce facilitation for every affectively related target word. In fact, however, affective priming effects can be obtained even when target words are randomly sampled from large pools of positive and negative words (Klauer, Roßnagel, & Musch, 1997), so that a spreading-activation mechanism of limited capacity seems unlikely. When an experiment involves only a few targets that are presented repeatedly, as has been the case in the tradition of the Fazio et al. (1986) paradigm, a modified spreading-activation account of limited capacity may, however, be possible. Spreading-activation accounts are attractive because they are consistent with the proposed automatic character of the evaluative response and its influence on subsequent processing. In addition, the stimulus-level version implies a highly general effect of spontaneous evaluations on almost any kind of subsequent processing, whereas under the evaluative-response mechanism, that influence is restricted to subsequent evaluative responses and judgments based on them.

Expectancy

Congruency effects can be explained largely in terms of the expectancy of the target item activated by the prime. The expectancy mechanism is a strategic explanation for priming, in which the participant forms expectations from the prime item and will thus strategically respond more quickly to a congruent target than an incongruent one. Unlike spreading activation, expectancy is a mechanism that is assumed to be under the participants' control. Expectancy-based mechanisms assume that participants actively form an expectancy set upon presentation of the prime that consists of potential targets in the case of stimulus-level accounts, or of the predicted evaluation of the target in the case of evaluative response mechanisms (Klauer, 1998). Unlike spreading activation, expectancy-based mechanisms are assumed to be 1) under the participants' strategic and intentional control, and 2) relatively slow acting (Posner & Snyder, 1975). In the context of affective priming, an explicit, though untested, assumption is that a stimulus onset asynchrony of 300 ms is too brief an interval to permit participants to develop an active expectancy or response strategy regarding the target item that follows; such conscious and flexible expectancies are thought to require at least 500 ms to develop and to influence responses in priming tasks (Bargh et al., 1996; Fazio et al., 1986).

Affective Priming in Music and Words

Sollberger et al. (2003) conducted a study using the affective priming paradigm to examine the interrelation of language and music by using chords as primes and words as targets. Participants were asked to evaluate the affective valence (i.e., positive or negative) of visually presented positive and negative target words as quickly as possible following the presentation of a short priming chord over headphones. The priming chords were either consonant chords with three notes or dissonant chords with four notes as priming items. The affective tone of the priming chord (evaluated in pretests as either positive or negative) influenced the evaluation of target words. Congruently primed target words were responded to faster than incongruently primed target words. In addition, it was found that even when participants were unaware of the true hypothesis of the experiment, they evaluated target words faster if the words were preceded by a congruent chord (e.g., consonant chord-holiday) as compared to an effectively incongruent chord-word pair (e.g., dissonant chord-humor). Later extensions of the first experiment showed similar findings when chord density was held constant (i.e., all presented items consisted of the same number of tones), further suggesting that the affective tone of single music elements is automatically extracted, and might therefore be a viewed as a basic process contributing to the strong connection between music and affect (Sollberger et al., 2003).

Semantic vs. Evaluative Categorization

While research examining the interaction between semantic and affective priming is scarce, several studies indicate independence between affective properties of words and lexical access (Klinger et al., 2000; Spruyt, Hermans, De Houwer, Vandromme & Eelen, 2007). Lexical access is the process by which the basic sound-meaning connections of language are activated. Spruyt et al. (2007) have suggested that perhaps semantic judgments do not influence affective judgments and vice versa when an individual is instructed be attentive to one or the other. However, the present research will attempt to explore the relationship between lexical access and affective properties through a variation on a lexical decision task using words and musical chords, along with artificial or contrast materials (nonwords and single musical notes).

It has been found that affective stimulus processing is reduced (responses are slowed) when participants selectively attend to nonaffective stimulus dimensions, such as categorical and lexical properties (Spruyt et al., 2007). Recent studies using lexical materials have shown that the affective priming effect typically fails to be observed when participants are asked to categorize targets on the basis of nonaffective stimulus features. Consider, for instance, Experiment 4 of Klinger et al. (2000). In this study, participants were presented with masked primes that were either related or unrelated to the targets on one of two dimensions: valence (positive vs. negative) and animacy (living vs. non-living). In addition, Klinger et al. (2000) manipulated the nature of the categorization task: whereas one group of participants was asked to categorize the targets on the basis of their valence, a second group of participants was asked to make animacy judgments. Despite the fact that identical stimulus materials were used in both conditions, Klinger et al. (2000) observed significant affective priming only when participants categorized the targets on the basis of their valence. Similar results were reported by De Houwer, Hermans, Rothermund, and Wentura (2002). Using visual primes, these researchers obtained significant affective priming when participants responded on the basis of the valence of the targets, but not when the semantic category (person or object) was relevant (Experiment 2). Likewise, Klauer and Musch (2002) failed to obtain the affective priming effect when participants categorized the targets on the basis of their location on the computer screen (Experiment 1), color (Experiment 2), letter case (Experiment 3), or grammatical category (Experiment 4), whereas strong affective priming effects were readily obtained in each of these experiments when participants were asked to categorize the targets on the basis of their valence.

Similar findings were reported by Spruyt et al. (2007). Participants were shown a series of positive and negative pictures that were used as primes and targets. The target pictures portrayed either animals or objects whereas the prime pictures portrayed more complex real life scenes. The task was to categorize the pictures as positive or negative (affective priming) or to categorize them as objects or animals (semantic priming). Different participants had variable amounts of the two types of tasks. Semantic priming was strongly reduced when participants were told to be attentive to affective stimulus features. Additionally, affective priming of nonaffective semantic categorization responses was obtained when participants were told to be attentive to the affective stimulus dimension. In each of the studies, affectively congruent and affectively incongruent primes did not influence categorization differentially.

Based on this pattern of results, several researchers have openly questioned the viability of the so-called encoding account of affective priming (e.g., De Houwer et al., 2002; Klauer & Musch, 2002; Klinger et al., 2000). According to this account, affective priming effects emerge because affectively polarized prime stimuli preactivate the memory representations of affectively related targets to an extent that it becomes easier to encode targets with the same valence than targets with a different valence. Thus, the affective dimension of all pleasant/happy stimuli becomes activated upon the presentation of a pleasant/happy prime stimulus. Because such a process is assumed to occur irrespective of the nature of the categorization task, the observation that the affective priming effect typically fails to occur in nonaffective (semantic) categorization tasks is indeed inconsistent with an encoding account. An encoding account would make the assumption that affective properties would still play a role in facilitating responses regardless of the task directive (Spruyt et al., 2007). A categorization level account of affective priming, on the other hand, fits nicely with the observation that affective priming effects are dependent upon the nature of the categorization task. According to this account, affective priming effects can come about only if affectively polarized prime stimuli can trigger categorization tendencies that facilitate or interfere with target processing (Klauer & Musch, 2002). Unlike in the standard evaluative categorization task (classifying a stimulus as positive or negative), this is not the case in the semantic (nonaffective) categorization tasks. Accordingly, the observation that the affective priming effect is readily obtained with the evaluative categorization task, but fails to occur in semantic (nonaffective) categorization tasks seems to corroborate the hypothesis that affective priming is primarily driven by processes that operate at a categorization stage (e.g., De Houwer et al., 2002; Klauer & Musch, 2002; Klinger et al., 2000).

A crucial difference between evaluative categorization tasks and semantic (nonaffective) categorization tasks is that participants are required to assign attention to affective stimulus features (i.e., decide between positive and negative, pleasant and unpleasant, happy and sad) in the evaluative categorization task, whereas selective attention for semantic stimulus features (i.e., decide between animal and object, bird and reptile) is required in semantic (nonaffective) categorization tasks. On the assumption that processes operating at an encoding level do contribute to the affective priming effect, one could argue that it should be possible to find significant affective priming of semantic (nonaffective) categorization responses if the broader experimental context encourages participants to process the affective stimulus dimension, thus generating congruency effects with the affective similarities of the prime and the target facilitating reaction times. Conversely, one could also predict that the affective priming effect will be less likely to emerge, even in the evaluative categorization task, if the broader experimental context causes participants to ignore the affective stimulus dimension.

Current Studies

The present research used the affective priming paradigm as a means of evaluating responses to target items. This paradigm has a supreme methodological advantage: by contrasting performance on congruent prime-target pairs (prime and target are both positive or both negative) with incongruent pairs (one positive, the other negative), the affective priming effect does not rely on comparisons of different sets of words (such as comparison of positive versus negative words, as in negativity effects). The same words can be placed in congruent as well as incongruent prime-target pairs. It is therefore unlikely that uncontrolled aspects of the words (familiarity, informational diagnosticity, extremity, etc.) can explain affective priming effects if they occur (Klauer, 1998). Similar controls are in possible with music stimuli. Thus, the paradigm permits the investigation of whether congruency across emotion can influence target evaluations among a variety of stimulus types (words, nonwords, musical sequences, chords and notes).

Experiment 1 investigated whether emotional congruency influenced judgments of affect in happy and sad words. The experiment was designed to investigate whether the particular stimuli chosen, which were to be used in subsequent studies, produced a congruency effect independent of music stimuli. Participants heard pairs of words and were asked to respond 'happy' or 'sad' to the second item by pressing one of two buttons on a button box. The design of the study was similar to previous affective priming research (Fazio et al., 1986), however, participants were presented with stimuli solely in the auditory modality. Past affective priming studies have used cross-modal (Sollberger et al., 2003) or visually presented stimuli (De Houwer et al., 2002). It was important, however, to the current research to remain consistent in presenting stimuli in the auditory modality, as the music stimuli used in Experiments 2 and 3 required auditory presentation. Furthermore, it was of interest as to whether congruency effects could be observed completely within the auditory domain, as stimulus presentation tends to be longer in the auditory domain and it has been previously suggested that there may be limitations on stimulus length to achieve affective priming (Klauer, 1998)

Experiment 2 investigated whether emotional congruency influenced judgments of emotion, both within and across musical and lexical domains. This time participants were auditorily presented with pairs of words, musical sequences or both, and responded 'happy' or 'sad' to the second item by pressing one of two buttons on a button box. Similar to the Sollberger et al. (2003) study, shorter affective judgment times were expected when the stimuli were emotionally congruent than when they were emotionally incongruent. Additionally, it was expected that shorter reaction times would be observed within the same type of stimuli (Music-Music and Word-Word) conditions than the mismatching stimuli (Word-Music and Music-Word) conditions, as cross category relationships might hinder response latencies. The experiment served to develop a new understanding of affective priming, by investigating the behavior of prime-target interactions when both word and music stimuli are used in the same pair.

In Experiment 3, a semantic judgment task, a variant of a lexical decision task, was carried out using words, nonwords, musical chords and musical notes, and it was of interest as to whether structural decisions were influenced by affective stimulus dimensions. It has been found that affective stimulus processing is reduced when participants selectively attend to nonaffective stimulus dimensions, such as categorical and lexical properties (Spruyt et al., 2007). This is of particular interest to the current research as emotional processing is examined independently (Experiment 1) across word and music stimuli (Experiment 2) and within a semantic judgment task (Experiment 3). Using a different procedure that is similar to a standard lexical decision priming task (in which an individual responds to a target item shortly following a prime item) a different outcome may be observed in Experiment 3. It is suggested from the Spruyt et al. (2007) findings that affective properties may not affect semantic judgments, however a study in which emotionally congruent words and chords are paired together along with other pairs of varying relatedness (i.e., word-nonword, nonword-musical note, chord-nonword, etc) has yet to be conducted. It is hypothesized that processing will be facilitated by the degree of relatedness on a semantic level (i.e., the processing of two presented words will be faster than processing of a word and a musical note) as well as the affective consistency (if any) between the prime and target (Klauer, 1998).

Experiment 3 built upon Experiment 2 by examining semantic categorization tasks using words, nonwords, musical chords and music notes. The task was to press a button if the target was a word or a chord and another if the target was a musical note or a nonword. Essentially, the participant was asked to distinguish between 'real' and 'artificial' items, in the sense that nonwords are lexically pronounceable but are not a part of English vocabulary and musical notes are non-referential in that they may possess very little relatedness to a chord if they are outside of its stable tonal context. The same words used in Experiment 1 were used in Experiment 3 and the trial numbers were doubled to assure an adequate amount of exposure to each stimulus. The purpose of Experiment 3 was to discover whether emotional properties found in the words and the major and minor chords could influence judgments in a semantic categorization task. It was predicted that responses would be faster following similar stimulus types (i.e. word-nonword pairs) and would also be further facilitated by similar item types (i.e., word-word pairs).

Experiment 1

It was expected that individuals would respond faster when items were emotionally congruent than when they were emotionally incongruent. The purpose of Experiment 1 was to replicate past emotional priming studies consisting of only words to confirm that the stimuli being used could produce congruency effects independently of the musical sequences they would hear in Experiment 2. Further, Experiment 1 also served to determine whether these congruency effects could be realized in an auditory presentation rather than visual presentation – a common methodological approach in other studies (as seen in the literature; e.g, Fazio et al., 1986).

Method

Participants. Thirty-two undergraduate students between the ages of 19 and 26 years (M = 22.45, SD = 3.43), from the Memorial University community participated in the study. All individuals were native English speakers, gave informed consent to participate (see Appendix B) and were paid a nominal fee for their participation. Most (89%) of the participants were right handed.

Stimuli. Words were synthesized using an Apple Macintosh computer and Logic Studio software. An IBM computer along with a TDT System sound controller was used to run the experiment. All words were extracted from a large list of norms (Bradley & Lang, 1999). Forty-eight happy words and 48 sad words were used in the experiment (see Appendix C). Rated arousal and valence for each of the words were used to choose the stimuli. Words with a high arousal rating (ranging from 7.3 – 9.2) and a high valence rating (6.3 – 8.7) were used as happy words. Words with a high arousal rating (ranging from 7.5 – 9) and a low valence rating (ranging from 2.6 – 1.1) were used as sad words. The 'Alex' voice, bundled with Mac OS X Leopard, was used as the presentation voice.

All stimuli were presented binaurally via Sennheiser HD-265 headphones. The stimuli were generated from stored raw files by a Tucker-Davis System III 24-bit D/A converter at a sampling rate of 22 kHz and were adjusted to a comfortable intensity (~70 dB) via a TDT programmable attenuator. Responses were collected from a dedicated button box connected to a TDT parallel interface module which records button presses with an accuracy of +/- 1 ms. The clock and stimulus were started by the same software trigger. Response times were measured from the onset of the stimulus, so include the stimulus duration. The stimuli ranged from 400 ms to 500 ms in length.

Design. The experiment was a 2 prime affect (Happy v. Sad) x 2 target affect (Happy v. Sad) within subjects design. There were 48 trials in total, involving 48 happy words and 48 sad words. Twenty-four happy words and 24 sad words were used as primes. For each of the primes, 12 happy words and 12 sad words served as targets and no words were used more than once. Each pairing could thus consist of a happy or sad word as the prime, with the same possibility occurring for the target. Order of condition (i.e., Happy-Sad) was randomized within each block.

Procedure. Participants were tested individually and were seated approximately 24 cm away from a computer screen. Once seated, the participants were told that they would be listening to two words and should respond to the second word that was presented. They were told to read the onscreen instructions, detailing the importance of a fast reaction to the test stimuli. Each participant was given four practice trials.

Following the practice trials, a set of onscreen instructions appeared. "In each trial, you will hear two words. After each pair of words is presented, please respond as quickly as you can by pressing the [LEFT/RIGHT] button if you thought the second word was HAPPY. Alternatively, if you thought the second word was SAD, please press the [RIGHT/LEFT] button. Please respond as quickly as possible to each item pairing. Responses should occur within 1 or 2 seconds of hearing the items. There are 48 trials in total and you will be given the opportunity to take a break after the 24th trial."

Each participant was asked to rest his or her hands on the two buttons placed in front of him/her. Throughout the experiment, there were onscreen instructions detailing which button to press for which emotion. The proper response for each button was labeled on the button box itself just above each of the response buttons. This response layout was counterbalanced across individuals. Following the onscreen instructions, the computer screen was masked with instructions "Press [left/right] for Happy or [right/left] for Sad."

Results

The analyses are based on correct responses (i.e., the correct category of happy or sad was chosen). All participants had fewer than 10% error rates. The overall accuracy rate was 92.6%, excluding removed outliers. Response times greater than three standard deviations from the mean (for each participant) were marked as incorrect and excluded from all analyses (2.7% of all responses). The mean response times for each of the four conditions (Happy-Happy, Happy-Sad, Sad-Happy and Sad-Sad) are shown in Table 1 and Figure 1.

Table 1

Experiment 1: Mean Response Times (ms) and Standard Deviations Across Emotional Valence

Emotion	Mean	Standard Deviation
Happy-Happy	819.23	237.88
Sad-Happy	958.40	226.26
Happy-Sad	960.13	205.62
Sad-Sad	828.69	160.44

$N = 32$

As can be seen in the table, the fastest response times observed in the emotion condition were Happy-Happy and Sad-Sad items ($M = 819.23$ ms and $M = 828.69$ ms, respectively), suggesting congruent word pairs were responded to faster than incongruent word pairs. A 2 (prime affect) x 2 (target affect) repeated measures analysis of variance (ANOVA) was performed on the response time data. There was no main effect of prime affect and no effect of target emotion (both F's <1) but there was a significant interaction, $F(1,31) = 16.62$, $MSE = 35{,}929$, $p < .05$, $d = .63$. Post hoc comparisons using Fisher's LSD test revealed that the Happy-Happy condition was significantly faster than the Happy-Sad ($p = .005$) and Sad-Happy conditions ($p = .006$). A similar trend was found for both Happy-Sad ($p = .008$) and Sad-Happy ($p = .009$) conditions when compared to the Sad-Sad condition, indicating a congruency effect. The two congruent conditions did not differ from one another ($p = .853$) nor did the two incongruent conditions ($p = .853$).

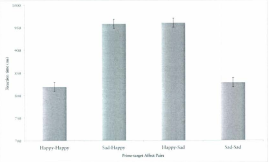

Figure 1. Experiment 1: Mean Response Times (ms) Across Prime-target Affect pairs. Error bars are standard error of the mean.

Discussion

Experiment 1 addressed the question of whether the chosen word stimuli could replicate an affective priming effect, an outcome typically found in the verbal priming literature. Also of interest was determining the ability to produce an affective priming affect with only auditory presentation of chosen words. A congruency effect was found, in which congruent prime and target pairs were responded to faster than dissimilar pairs.

Consistent with past findings, Happy-Happy and Sad-Sad prime-target pairs were responded to faster than incongruent pairs. In an early experimental demonstration, Fazio et al. (1986) asked participants to memorize attitude objects (e.g., sunshine, illness) that were presented as primes and to judge whether subsequently presented target adjectives (e.g., delicious) had positive or negative connotations. They found an affective congruency effect, in which responses to the targets were faster when the target was congruent with the prime (e.g., prime = sunshine; target = delicious) than when it was incongruent with the prime (e.g., prime = illness; target = delicious). This finding stimulated a flourishing literature (for reviews see the contributions in Klauer & Musch, 2002) and has been replicated with a variety of different primes.

Response times in the current study were well above the typical response times reported (Klauer, 1998; Klauer & Musch, 2002). It is probable that the increase in overall response time was due to the modality differences between the current study and past experimentation. The current study used computer-generated auditorily presented words as both prime and targets. One and two-syllable words were used with a maximum 500 ms of pronunciation time. It would have been unfavorable to the quality of the stimuli to enforce faster pronunciation, as the word stimuli would less resemble typical spoken words. Furthermore, regardless of the discrepancy between the absolute level of mean reaction times of current and past research, a congruency effect was produced, suggesting that affective priming can be obtained among a wider range of response times than previously reported.

Experiment 2

Experiment 1 showed that previously reported affective priming results could be produced using auditorily-presented words. Experiment 2 was designed to extend those results to musical stimuli, as well as to determine whether musical stimuli could act as affective primes for lexical stimuli and vice versa.

Method

Participants. Forty undergraduate students between the ages of 18 and 25 years (M = 21.66, SD = 2.13), from the Memorial University community participated in the study. To ensure that participants could distinguish between major and minor chords, they were tested for tone perception deficits using a brief version of the Montreal Battery of Evaluation of Amusia (MBEA; Delosis Limited, 2009; Peretz, Champod, & Hyde, 2003). Relevant information (e.g., gender, handedness, musical training, native language) was gathered using a brief questionnaire prior to beginning the experiment (see Appendix D). Musical training was measured by the total number of instrument-years of instruction. All participants reported having normal hearing and none reported having absolute pitch. The participants chosen for Experiment 2 did not participate in Experiment 1. All individuals were native English speakers, gave informed consent to participate and were paid a nominal fee for their participation. Most participants (81%) were right-handed.

Pre-test. Prior to actual experimentation, a pre-test was conducted on a selected sample of participants. Seventy-two musical sequences were rated by seven individuals using a Likert scale ranging from 1 (very sad/unpleasant) to 5 (very happy/pleasant). All musical sequences that were used had 100% rater agreement as Happy/Sad, with 95% of the ratings being the same overall, with all sequences (even those that were unused) included.

Stimuli. The word stimuli that were produced for Experiment 1 were also used in Experiment 2. Twenty-four tones were synthesized using Logic Studio software (C3, C#3, D3, D#3, E3, F3, F#3, G3, G#3, A3, A#3, B3, C5, C#5, D5, D#5, E5, F5, F#5, G5, G#5, A5, A#5 and B5) according to an equal-tempered tuning ranging from 103.8Hz to 1244.5 Hz in order to produce very short duration musical sequences (see Appendix E for sample notation). The 24 happy musical sequences consisted of five note events. The sequences can be characterized as being high in range, making an ascending contour and possessing a fast tempo. The duration of the sequences ranged from 0.9 s and 1.05 s in length. The 24 sad musical sequences had two separate notes in a descending interval and had durations between between 0.9 and 1.5 s. The lower two notes (e.g., D3, B3) had a length of 1.5 s in order to provide a discernable amount of sustain (it was decided in pre-tests that the lower notes ended too abruptly to produce the sad affect desired). The timbre used in this study was that of a typical concert piano. The apparatus was the same as in Experiment 1. Stimulus presentation software and hardware was the same as that used in Experiment 1.

Design. The experiment was a 2 prime affect (Happy v. Sad) x 2 target affect (Happy v. Sad) x 2 prime type (Word v. Melody) x 2 target type (Word v. Melody) within-subjects design. There were 96 trials in total. Twenty-four happy words, 24 sad words, 24 happy musical sequences and 24 sad musical sequences were used as primes. Each of the four blocks used 6 happy words, 6 sad words, 6 happy musical sequences and 6 sad musical sequences as targets. No word or musical stimulus was repeated. Each pairing could thus consist of a happy or sad word or a happy or sad musical sequence as the prime, with the same possibilities occurring for the target. The stimuli that were the primes for half the participants became the targets for the other half. Order of condition (i.e., Happy/Sad or Music-Music) was counterbalanced across participants and randomized within each block. All stimuli were presented auditorily through Sennheiser headphones at a comfortable volume level.

Procedure. A similar procedure to Experiment 1 was used for Experiment 2. The only differences were that participants had 96 trials and were presented with both word stimuli and music stimuli.

Participants were tested individually and were seated approximately 24 cm away from a computer screen. Once seated, the participant was verbally given brief instructions that he or she would be listening to two sounds – either two words, two musical sequences or some combination of the two – and would be asked to determine whether the second item was happy or sad by pressing a button on a dedicated timer box. He or she was told to read the onscreen instructions, detailing the importance of a fast reaction to the test stimuli. Each participant was given four practice trials, with each trial demonstrating a different set of possible item pairings (e.g., word/music).

Following the practice trials, the following onscreen instructions appeared: "You will hear a series of words and musical sequences. Each pairing may consist of two words, two musical sequences or a word and a musical sequence. After each pairing, please respond as quickly as you can by pressing the [LEFT/RIGHT] button if you thought the second item was HAPPY. Alternatively, if you thought the second item was SAD, please press the [RIGHT/LEFT] button. Please respond as quickly as possible to each item pairing. Responses should occur within 1 or 2 seconds of hearing the items. There are 96 trials in total and you will be given the opportunity to take a break after every 24 trials."

Each participant was asked to rest his or her hands on the two buttons placed in front of him/her. Throughout the experiment, there were onscreen instructions detailing which button to press for which emotion. The proper response for each button was labeled on the button box itself just above each of the response buttons. This response layout was counterbalanced across individuals. Following the onscreen instructions, the computer screen was masked with instructions "Press [left/right] for Happy or [right/left] for sad."

Following the experiment, participants were given a form that asked the following questions: 1) In your own words, what did you think the experiment was about?; 2)What do you think was our scientific question?; and 3) What was our proposed explanation for the question? It was of interest whether participants could correctly guess the hypothesis of the study and furthermore what effect their knowingness had on response timing (see Appendix F). Participants were believed to be knowledgeable if they reported a connection between the emotional connotation of the musical sequences (happy versus sad) and their facilitative influence on the processing of congruent versus their inhibiting influence on the processing of incongruent target words and musical sequences.

Results

All individuals passed the MBEA test and were able to participate in the experiment. The mean number of instrument-years of instruction was 1.7 years (*SD* = 6.23), suggesting that participants were, in general, not well trained musically. Sixty-eight percent of participants reported taking a music course in university and only 19% considered themselves a musician or music major. Of the 40 participants, 21 had relatively good insight into the research hypothesis and 35 were aware that the connection between music and language was being explored.

The analyses are based on correct responses (i.e., the correct category of happy or sad was chosen). Overall accuracy rate was 88.7%, excluding removed outliers. Response times greater than three standard deviations from the mean (for each participant) were marked as incorrect and excluded from all analyses (1.6% of all responses). Three participants with error rates above 15% were replaced and neither their demographic or performance data were included in the analysis.

Mean response times for each of the conditions (16 in total: four affect (Happy-Happy, Happy-Sad, Sad-Happy and Sad-Sad) each crossed by four item pairs (Word-Word, Word-Music, Music-Word and Music-Music) are shown in Table 2.

Table 2

Experiment 2: Mean Response Times (ms) and Standard Deviations Across Emotional Valence and Item Pairs

Conditions			
Affect	Pairs	Mean	Standard Deviation
Happy-Happy (M = 1469.84)	Word-Word	1262.15	431.13
	Word-Music	1695.73	686.84
	Music-Word	1276.62	447.88
	Music-Music	1644.87	693.23
Sad-Happy (M = 1575.61)	Word-Word	942.96	377.95
	Word-Music	2130.67	707.26
	Music-Word	1023.87	517.16
	Music-Music	2205.09	673.16
Happy-Sad (M = 1639.41)	Word-Word	866.94	313.45
	Word-Music	2079.34	745.92
	Music-Word	1051.27	427.22
	Music-Music	2560.44	774.94
Sad-Sad (M = 1463.37)	Word-Word	1127.70	380.01
	Word-Music	1442.97	564.96
	Music-Word	1501.21	428.80
	Music-Music	1781.61	817.20

N = 40

First, it should be noted that overall, response times in this experiment were much slower than in Experiment 1 (M = 1,537 ms and M = 891 ms, respectively). This is not surprising given that word and music targets were randomly intermixed. Thus, there was a certain amount of task switching required. In addition, it can be assumed that responding quickly to musical stimuli is not something usually done in everyday life, in contrast to the everyday task of quickly decoding words in everyday conversation. Of interest was the observation of faster responses with congruent item than with incongruent item pairs, and faster responses to word than to musical targets. Indeed, overall, word targets were responded to faster than music targets (M = 1,350 ms and M = 1,943 ms, respectively).

As can be seen in Table 2, the fastest response times observed in the emotion pairing condition were Happy-Happy and Sad-Sad items (M = 1,469.84 ms and M = 1,463.37 ms, respectively), suggesting that congruent pairs were responded to faster than incongruent pairs (Happy-Sad: M = 1,639.41 and Sad-Happy: M = 1,575.61). Across item types, Word-Word (M = 1,049.94 ms) and Music-Word pairs (M = 1,213.24 ms had faster response times than Music-Music (2,048.00 ms) and Word-Music pairs (1,837.18 ms), suggesting that word targets were responded to faster than music targets.

A 2 (prime affect) x 2 (target affect) x 2 (prime type) x 2 (target type) repeated measures analysis of variance (ANOVA) was performed on the response time data. Neither the main effect of prime or target affect was significant ($F(1,39) = 1.05$, MSE = 189,609, $p = .31$, $d = .067$ and ($F(1,39) = .60$, MSE = 215,575, $p = .44$, $d = .062$ respectively). There were main effects of prime type ($F(1,39) = 77.76$, MSE = 71,915, $p < .01$, $d = .49$ and target type ($F(1,39) = 140.00$, MSE = 751,685, $p < .01$, $d = .54$) with words being generally responded to faster than musical sequences. Collapsing across item types there was an interaction of prime and target valence such that the congruent pairs (Happy-Happy, M = 1,470 ms; Sad-Sad, M = 1,463) were responded to faster than the incongruent conditions (Happy-Sad, $M = 1{,}639$ ms; Sad-Happy, $M = 1{,}576$ ms), replicating Experiment 1.

(None of the other main effects or 2-way interactions were significant with the exception of the target valence x prime type interaction ($F(1,39) = 42.08$, $MSE = 3965791$, $p < .01$, $d = .56$) and the prime valence x target type interaction ($F(1,39)=5.01$, $MSE = 156{,}227$, $p < .01$, $d = .46$). These interactions can be subsumed into the discussion of the 3-way interaction, below.)

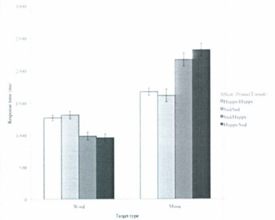

Figure 2. Experiment 2: Mean Response Times (ms) For Each Target Type Across Emotional Valence. Errors bars are standard error of the mean.

On closer inspection, a congruency effect was only found when musical sequences were targets (see Figure 2). This comes out in the analysis as a significant three-way interaction of prime valence, target valence, and prime type ($F(1,39) = 234.39$, $MSE = 34{,}072{,}290$, $p < .01$, $d = .37$). Inspection of the means showed that there was a congruency effect when musical stimuli were the targets (Fisher LSD--Happy-Happy (M = 1,670 ms) = sad-sad (M = 1,612 ms) < Sad-Happy (M = 2,168 ms) < Happy-Sad (M =

2,319 ms)). However, when words were the target there was an apparent hedonic contrast effect, rather than a congruency effect. In other words, opposite affects resulted in *faster* responses than congruent affects (Fisher LSD-- Happy-Happy (M = 1,269 ms) = Sad-Sad (M = 1,314 ms) > Sad-Happy (M = 983 ms) = Happy-Sad (M = 959 ms). The left half of Figure 2 shows the pattern when words were the targets (contrast effect) and the right shows the pattern when musical sequences were the target (congruency effect). This pattern was essentially the same whether the prime stimulus was music or words, thus there was no significant four-way interaction ($F(1,39) = 3.85$, $MSE = 99,450$, $p = .06$, d = .09).

Following the completion of the testing, each participant was asked to write a few sentences answering the question: "What did you think the experiment was about?" Thirty-nine participants (97.5%) stated that the relationship between the prime and target items was important, 35 participants (87.5%) understood the emotional agreement between the two items and 34 participants (85%) understood that the topic of interest was emotion within music and words.

Discussion

Word stimuli were responded to faster than musical stimuli, which might be expected given that in the auditory domain, words are processed faster than musical stimuli (Blair, Richell, Mitchell, Leonard, Morton & Blair, 2006). In addition, it is possible the word target stimuli were less ambiguous in their affect by virtue of their meaning. Third, the individuals who participated in this experiment were not musically well-trained (only 1.7 years of instrument training across all participants) and thus may have processed music slower simply due to less exposure. It would be of interest to investigate whether this word target effect would disappear in a similar experiment using solely musically trained participants.

A congruency effect was found when musical sequences were used as targets. For word targets, however, contrast effects were found. With regard to the music stimuli, the findings were expected and suggest that such priming results can occur within the music domain as well as across categories. The unexpected results of the word target data suggest that presentation conditions (i.e., presenting a musical sequence followed by a word) were likely important in creating this relatively small contrast effect. In the literature, a positive contrast effect occurs when good things are rated more highly if they follow bad things than if they do not. Negative contrast effects are the exact opposite. In a study by Arieh and Marks (2003), the participants were exposed to a series of tones at two different frequencies. In one condition, the low-frequency tone series was louder than the high frequency tone series. In the other condition, it was the reverse. Participants judged a moderately loud tone as softer when other tones of its frequency were loud than when other tones of its frequency were soft. In a study including affective judgments, Parker, Bascom, Rabinovitz and Zellner (2008) presented individuals with "good" musical selections before "bad" ones and vice versa. Goodness was defined as steady and rhythmic melodies, with typically Western consonant harmonies (predominantly major thirds and perfect fifths). Bad melodies were arrthythmic with dissonant harmonies and minor seconds and diminished fifths ever-present. Participants' evaluations of those stimuli exhibited both positive and negative hedonic contrast effects.

In the word target conditions of Experiment 2, the incongruent Happy-Sad and Sad-Happy pairs were processed faster than congruent pairs, which is atypical of past findings in the literature (Fazio et al., 1986; Fazio, 2001). Interestingly, in Experiment 1, a congruency effect was found using the same word stimuli albeit in an isolated manner. Perhaps a shift from congruency occurred in these Word-Word and Music-Word pairs due to the nature of contrasting two extremes. Thus, presenting an affectively sad word before a happy word aided in making a decision about the target word, and vice versa. Additionally, presenting a musical stimulus and following it with an affectively incongruent word may have enhanced decision-making for the target word. The stimuli were only affectively happy or sad, and no stimuli were neutral. It is possible then, that there were clear contrasts between the two items, making a more distinctive evaluation possible for the target item. The results were inconsistent with those of Sollberger et al. (2003) in that, words primed by musical stimuli did not produce a congruency effect. However, musical stimuli primed by words did show a congruency effect. In addition to explaining the results through hedonic contrast, perhaps word stimuli took precedence over music stimuli and regardless of the prime, processing was facilitated as a result of word targets, thus reducing the priming effect of music stimuli in this condition.

The present experiment explored affective priming in a novel way, using stimulus types and conditions that had not been fully tested previously in the manner that they were examined in this thesis. Except for an initial exploration of musical chords priming word stimuli (Sollberger et al., 2003), priming experiments in which both word and music stimuli served as primes and targets in congruent and incongruent affective pairs have not been conducted to date. Thus, further experimentation is required to explore the conditions under which congruency or contrast are obtained.

It is interesting to observe priming behaviors within language and music domains, specifically within the affective priming paradigm where complimentary properties of music and language exist. The challenge, however, in examining the interrelation of music and language is recognized when semantic processing is considered. With this in mind, a common method of semantic processing must be explored in order to understand the interrelatedness of the two domains. With music and language possessing affective properties that are in most circumstances compatible and congruous, this interrelation can be explored within semantic priming.

Experiment 3

In the third experiment, the goal was to determine whether affect could influence judgments of meaningfulness and whether congruency would influence such judgments. To clarify, a semantic judgment implies making a decision about the denotative, literal meaning of the stimuli, not the emotional or connotative properties that could have also been interpreted. A semantic judgment task was carried out, using the words from Experiment 1 along with musical chords, nonwords and musical notes. Nonwords and musical notes were used as contrasts to real words and musical chords. Real words and musical chords possess both semantic and emotional properties, whereas nonwords and musical notes do not. Nonwords possess no inherent semantic or emotional qualities, however pronounceable nonwords may evoke some semantic activation with close orthographic neighbors (Neely, 1971). A musical note may possess meaningful qualities based on its association with other notes or chords around it. For instance, if a C major chord is played and is followed by a C note, not only is the C note replayed, but it is also meaningfully associated with the C major chord played before it. A similar association would occur if an F major chord and a C note were played one after the other, as the F major chord has a C note as its perfect fifth. A way to dissociate a chord from a note as much as possible would be to play a chord (e.g., C major) followed by a note that is neither the chord's tonic, (e.g., C), perfect third (e.g., E), or perfect fifth (e.g., G). Although it can be argued that there is a degree of association between any notes or chords, a purposeful level of dissociation can be analogous to the limited relationship between words and nonwords. In this regard then, responding to nonwords and musical notes in a semantic judgment task was simply making a judgment about the identity of the stimulus. Both nonwords and music notes were thus considered to be neutral, so it was assumed that they were not processed emotionally and that they could only be evaluated on a semantic or meaning-based level. Following Crowder (1984), major chords were considered to be happy and minor chords were considered to be sad.

Also under investigation in Experiment 3 were the affective properties of the word and chord stimuli. Happy and sad words, as well major (pleasant/happy) and minor (unpleasant/sad) chords were presented amongst nonwords and musical notes. Although the binary response in the experiment was based on the semantic properties of the target (i.e., is this a word/chord or neither?), it was of interest as to whether the embedded congruency or incongruency of items affected the individuals' response. There were an equal amount of affectively congruent and contrasting pairs, within and across item type.

Method

Participants. Forty undergraduate students between the ages of 18 and 25 years (M = 22.04, SD = 2.89), from the Memorial University community who had not participated in Experiments 1 and 2 were used in the study. Participants were once again required to be able to distinguish between major and minor chords and were screened for tone perception deficits using a brief version of the Montreal Battery of Evaluation of Amusia (Delosis Limited, 2009, Peretz et al., 2003). All participants reported having normal hearing and none reported having absolute pitch. All individuals were native English speakers, gave informed consent to participate and were paid a nominal fee for their participation. Most of participants (90%) were right-handed.

Stimuli. Words used in Experiment 3 were the same as those used in Experiments 1 and 2. Nonwords were developed from words in the Bradley and Lang (1999) corpus (see Appendix G) and were synthesized using Logic Studio software. The chosen words were jumbled so that they were no longer real English language words, however the strings were still pronounceable. The word list was equated for time of pronunciation and equal numbers of one-syllable and two-syllable nonwords were used. The single notes and chords were also created with Logic Studio software and possessed identical presentation lengths (900 ms). Presentation software and hardware were identical to those used in the previous experiments.

The 24 major and minor chords and 12 single musical notes (C3, C#3, D3, D#3, E3, F3, F#3, G3, G#3, A3, A#3 and B3) synthesized for the experiment, all with a standard concert piano timbre.

Design. The experiment was a 2 (prime type) x 4 (target type) repeated measures design. In addition, affect was manipulated parametrically within the meaningful conditions (by definition the non-meaningful stimuli have no particular affect associated with them). Thus, affect was nested within the meaningful stimuli. There were 96 trials in total. Four sets of stimuli were used: 24 words, 24 musical chords, 24 nonwords and 12 musical notes. Four different conditions were randomized over trials. However, only words and chords served as primes. Twenty-four happy words, 24 sad words, 24 major chords and 24 minor chords acted as primes. Target pairing was broken down in groups of 8, with a happy word, a sad word, a major chord, a minor chord, two nonword and two single note targets accompanying each respective type of prime. Each pairing was tested three times, totaling 96 trials as per Experiment 2. The reason behind having two nonword and two single note pairings was to provide an equal number of Word or Chord and Nonword or Nonchord responses. When a chord acted as a prime and a single note acted as a target, the target note was not any of the notes within the chord, nor was it the major seventh of that chord (e.g., if a D major chord was played, the target note was not D, F#, or A). Order of condition (e.g., Word-Word, Word-Chord) was counterbalanced across participants and randomized within each block. All stimuli were presented auditorily through Sennheiser headphones at a comfortable volume level.

Procedure. Participants were tested individually and were seated approximately 24 cm away from a computer screen. The experimenter briefed the participant as to how the experiment would proceed. They were asked to read the onscreen instructions, describing the importance of a fast reaction to the test stimulus, which followed the prime stimulus. Prior to the beginning of the actual experiment, eight practice trials were given consisting of two happy words, two sad words, two major chords and two minor chords as primes, and a happy word, a sad word, a major chord, a minor chord, two nonwords and two single notes as targets. After the participant assured the experimenter that he or she understood the experiment, the experimental trials began.

The following set of onscreen instructions appeared: "You will be presented with a series of words, nonwords, musical notes and musical chord pairings. After each pairing, please respond by tapping the [LEFT/RIGHT] button if you thought the second item was a word or a chord. Alternatively, if you thought the second item was not a word or a chord, please press the [RIGHT/LEFT] button. If you are unfamiliar with the word you are hearing, chances are that it's a nonword. A musical note is not as full sounding as a chord (a chord consists of three, sometimes more notes played simultaneously."

"Please respond as quickly as possible to each item pairing. There are 96 trials in total and you will be given an opportunity to take a break after every 24 trials."

Each participant was asked to rest his or her hands on the two buttons placed in front of them. The participant was asked to press one button if he or she believed the target stimulus was a word or a chord. Alternatively, if he or she believed the stimulus was neither a word nor a chord, he or she was asked to press the other button. There was one button on each side of the reaction time box and the given responses were counterbalanced across individuals. Following the onscreen instructions, the computer screen was masked with instructions "Press [left/right] for word/chord or [right/left] for neither."

Results

All individuals passed the MBEA test and were able to participate in the experiment. The mean number of instrument-years of instruction was 2.3 years (SD = 5.67), suggesting that participants were, in general, not well-trained musically. Forty-eight percent of participants reported taking a music course in university and 29% considered themselves a musician or music major.

The analyses are based on correct responses (i.e., the correct category of Chord/Word or Neither was chosen). Overall accuracy rate was 91.3%. Response times greater than three standard deviations from the mean (for each participant) were marked as incorrect and excluded from all analyses (4.1% of all responses, not included in overall accuracy rate).

Two separate analyses were performed on the data. First, a 2 prime type (word, chord) x 4 target type (word, chord, nonword, note) repeated measures ANOVA was performed to examine the relationship among responses to meaningful and nonmeaningful with words and musical stimuli. Second, in order to examine how affect had an impact on the semantic judgment task, the meaningful stimuli were analyzed on their own. Thus, the second analysis was 2 prime type (word, chord) x 2 target type (word, chord) x 2 congruency (congruent/incongruent) repeated measures analysis.

The mean reaction times for each of the eight prime-target pairs (Word-Word, Chord-Word, Word-NonWord, Chord-NonWord, Word-Chord, Chord-Chord, Word-NonChord and Chord-NonChord) are shown in Table 3.

Table 3

Experiment 3: Mean Response Times (ms) and Standard Deviations For Prime-Target Pairs

Pairs	Mean	Standard Deviation
Word-Word	762.16	113.35
Chord-Word	875.45	176.83
Word-Chord	786.45	243.34

Chord-Chord	842.02	148.23
Word-NonWord	926.34	257.28
Chord-NonWord	896.68	201.45
Word-NonChord	862.95	334.23
Chord-NonChord	822.22	224.85

$N = 40$

Overall response times were faster in this experiment ($M = 846.78$ ms) than in Experiments 1 and 2. This is perhaps due to the single pieces of information presented in the musical stimuli rather than the melodically dense information contained within the musical stimuli for Experiment 2. Additionally, a semantic judgment was being made here rather than an affective judgment, which perhaps changes the speed of processing the target items. As can be seen in the table, the fastest response times observed were in the Word-Word and Word-Chord conditions ($M = 762.16$ ms and $M = 786.45$ ms, respectively), suggesting that word primes with "real" items are targets were responded to fastest. To examine the time to make semantic judgments, a 2 (prime type) x 4 (target type) repeated measures analysis of variance (ANOVA) was performed on the response time data across target type. A significant main effect of target type was found, $F(1,39) = 5.63$, $MSE = 24{,}983.49$, $p < .001$, $d = .54$, however, there was no significant main effect of prime type, $F(1,39) = 2.12$, $MSE = 18{,}234.09$, $p = .13$, $d = .07$. A graphical depiction of the data can be seen in Figure 3.

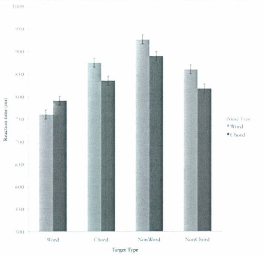

Figure 3. Experiment 3: Mean Response Times (ms) For Each Target Type Across Prime Type. Error bars are standard error of the mean.

Post hoc comparisons using Fisher's LSD test revealed that responses in the Word-Word condition (762.16 ms) were significantly faster than those in the Word-Chord condition 786.45 ms; $p < .01$). However, responses in the Chord-Word condition (875.45 ms) were significantly slower than in the Chord-Chord condition (843.02 ms; $p = .007$), indicating a stimulus congruency effect: when the type of stimulus was matched, responses were faster than when there was a mismatch. Interestingly, chords served as better primes for the non-meaningful stimuli than did words (all p's <.05). Overall responses to the nonwords were the slowest when compared to all the other conditions and the nonchord target responses did not differ significantly from the chord target conditions, regardless of the prime type.

Within Word-Word and Chord-Chord conditions, response times to congruent and incongruent affective pairs were also examined. These data can be seen in Figure 4.

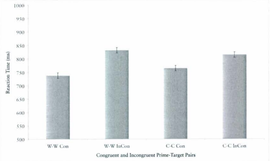

Figure 4. Experiment 3: Mean Response Times (ms) for Word-Word and Chord-Chord conditions for Congruent Pairs and Incongruent Pairs. Error bars are standard error of the mean.

To examine the effect of affective congruency on time to make a semantic judgment, a 2 (prime type) x 2 (target type) x 2 (congruency) repeated measures analysis of variance (ANOVA) was performed on the response time data for the word and chord item pairs (the congruency manipulation does not make sense for the

NonWord/NonChord stimuli and so was removed from this analysis). A graphical depiction of the data can be seen in Figure 4.

Main effects of prime type ($F(1,39) = 7.14$ $MSE = 170{,}978$, $p = .02$, $d = .41$) and congruency ($F(1,39) = 4.92$, $MSE = 23{,}178$, $p = .02$, $d = .36$ were significant. Congruent items ($M = 756.34$) were responded to faster than incongruent items ($M = 822.87$). The effect of target type ($F(1,39) = .67$ $MSE = 1{,}668$, $p = .79$, $d = .054$) was not significant. A three-way interaction between prime type, target type and congruency was also not significant ($F(1,39) = 1.87$, $MSE = 29{,}465$, $p = .23$, $d = .035$), however, an interaction was found between prime type and target type ($F(1,39) = 22.12$ $MSE = 503{,}648$, $p = .001$, $d = .56$). Word-Word ($M = 787.14$) and Chord-Chord ($M = 793.89$) items were responded to faster than Word-Chord ($M = 887.12$) and Chord-Word ($M = 866.47$) items. Graphically, it can be seen that congruent pairs ($M = 736.10$) were responded to faster than incongruent pairs ($M = 841.33$) in the Word-Word condition and Fisher LSD comparisons confirmed that observation. However, although there was a trend in the right direction, the Chord-Chord pairs congruent pairs ($M = 763.78$) were not significantly different from the incongruent pairs ($M = 810.12$).

Discussion

Experiment 3 examined affective congruency effects embedded within a non-affective judgment task. The participant was asked to determine whether a target item was a word, chord, nonword or nonchord. A stimulus type congruency effect was found with faster responses to targets that shared the same category as the prime (word or chord). The non-meaningful stimuli were added to the design mainly to act as fillers, but, consistent with the literature, nonwords were responded to the slowest, regardless of the prime. Tones and chords showed equivalent patterns. No real predictions were made regarding the responses to notes.

Considering just the meaningful stimuli, an affective congruency effect was found, in which similarly affective word primes and word targets were responded to faster than dissimilar word pairs. Although the same effect was not reproduced in the music stimuli a trend can be seen in Figure 4 indicating that it might be possible to observe the effect with an increased sample size. The experiment further elaborates on the nature of the congruency effect, demonstrating that it can occur cross-domain (as was seen in Experiment 2) and in conjunction with a non-affective task (semantic judgment task). Such findings demonstrate that affective similarity (congruency) among items is influential regardless of a conscious, strategic focus on the affective dimension.

The results of Experiment 3 suggest that the affective priming effect may not be the conditional phenomenon that several researchers have claimed it to be. In this study, even though the pairs were classified on the basis of their semantic properties, affective priming emerged when two congruent words or chords were presented. This pattern of results can be explained by assuming (a) that participants selectively assigned attention to stimulus dimensions that were relevant for response selection but not necessarily central to the task, and (b) that automatic affective stimulus processing can occur even if nonaffective semantic stimulus dimensions are selectively attended to. Consider, for example, the fact that affective priming effects have been obtained with the naming task as well as the lexical decision task (e.g., Bargh et al., 1996; De Houwer et al., 2001). In these tasks, all semantic stimulus features were equally relevant for response selection. It can thus be assumed that participants, when naming target words or judging their lexical status, divide their attention across various stimulus dimensions, including the inherently important affective stimulus dimension. Such results were in contrast to the findings of Spruyt et al. (2007) where it was found that affective stimulus is significantly reduced when individuals are given a semantic processing task, The methodology of the current studies differ dramatically from those of Spruyt et al. (2007). It can be argued that the standard priming methodology (as seen in the current study) provides a more viable framework for accentuating the affective qualities of the stimuli within a semantic judgment task. Additionally, perhaps these phenomena only occur in the auditory domain; the Spruyt et al. (2007) study used visual images as their stimuli.

General Discussion

Experiment 1 replicated previously-reported affective priming studies using auditorily presented lexical stimuli. The data showed a congruency effect, with pairs of congruent stimuli (Happy-Happy and Sad-Sad) being responded to faster than incongruent pairs (Happy-Sad and Sad-Happy). Experiment 2 extended the affective priming paradigm to include musical and lexical stimuli priming one another. Affectively congruent pairs were responded to fastest and target words were responded to faster than music targets, although that finding was qualified by a hedonic contrast effect when the word stimuli were the targets. The goal of Experiment 3 was to observe affective priming within a semantic judgment task, deciding whether a target item was real (word or chord) or artificial (a nonword or a single music note) rather than whether it is pleasant or unpleasant. The results of this study demonstrated limits on the ability of words and chords to prime one another. Although congruency effects were evident, significant differences were only found when words were used as targets. The implications of these results are summarized below.

The generality of the affective priming effect is now well established and has been validated using different types of stimuli and procedural variations (Sumner & Samuel, 2007, the current Experiment 1). Experiment 2 built upon one of the first experiments in which musical chords and words were used as primes and targets, respectively (Sollberger et al., 2003). In that study, affective congruency was observed between musical chord primes and word targets. In two experiments, Sollberger et al. (2003) observed affective priming using consonant and dissonant chords as primes and words as targets: target words were evaluated faster and more correctly if an affectively congruent chord was presented as a prime. These findings are also in line with existing theoretical and empirical work that demonstrates the emotional significance of music. Infants (presumed to be mostly lacking experiential influence) have been shown to prefer consonant to dissonant melodies, suggesting that explicit musical knowledge may not be required for such preferences (Zentner and Kagan, 1998). Similar conclusions were drawn from a Tillmann et al. (2000) review, in which evidence that culture-specific musical knowledge is acquired as the product of passive exposure to a culture's music and therefore becomes mentally represented.

Contrast Effects

Although the typical and robust finding is assimilation (i.e., target processing is facilitated by consistent primes relative to inconsistent primes), a number of contrast effects have been reported over the years. In priming measures of implicit attitudes and prejudices, for instance, priming measures are compromised where contrastive effects unexpectedly underlie the observed priming effects. Contrast effects are theoretically provocative because they pose problems for theoretical accounts of evaluative priming. In one view, activation spreads from valenced primes to concepts related in valence, causing priming effects in evaluations. In this account, spreading activation can explain only assimilation, not contrast. Although spreading activation is usually seen as causing facilitation, Berner and Maier (2004) suggested that activation turns into inhibition once a certain level of activation is exceeded, as might be the case for extreme primes and highly anxious participants in their view. Hermans, Spruyt and Eelen (2003), on the other hand, argued that activation might turn into inhibition for the weakest primes. Regardless, contrast effects exist in a variety of capacities within the priming literature through a variety of manipulations such as action valence blindness, success and failure feedback, positivity proportion effects and emphasis on accuracy (Klauer, Teige-Mocigemba & Spruyt, 2009).

Hedonic contrast effects can help to explain the results in the Word-Word and Music-Word conditions of Experiment 2. A positive contrast effect occurs when good things are rated more highly if they follow bad things than if they do not. Negative contrast effects are the exact opposite. In a study by Arieh and Marks (2003), the experimenters exposed participants to a series of tones at two different frequencies (500Hz and 2500Hz). In one condition, the low-frequency tone series was louder than the high frequency tone series. In the other condition, it was the reverse. Participants judged a moderately loud tone as softer when other tones of its frequency were loud than when other tones of its frequency were soft.

In the affect conditions of Experiment 2, Happy-Sad and Sad-Happy pairs were processed faster than congruent pairs. Perhaps a shift from congruency occurred in these Word-Word and Music-Word pairs due to the nature of contrasting two extremes. Thus, presenting an affectively sad word before a happy word aided in making a decision about the target word, and vice versa. Additionally, presenting a musical stimulus and following it with an affectively incongruent word enhanced decision-making for the target word. The stimuli were only affectively happy or sad, and no stimuli were neutral. It is possible then, that there were clear contrasts between the two items, making a more distinctive evaluation possible for the target item. The results were inconsistent with those of Sollberger et al. (2003) in that, words primed by musical stimuli did not produce a congruency effect. In addition to explaining the results through hedonic contrast, perhaps word stimuli took precedence over music stimuli and regardless of the prime, processing was facilitated as a result of word targets, thus reducing the priming effect of music stimuli in this condition.

In Experiment 2, participants' self-rated musicality (reported as mean instrument-years training) and their awareness of a possible effect of prime-presentation on target evaluation was collected. As reported in the literature, musical training does not appear to be a requirement for musical priming (Bigand et al., 1999) and thus obtaining priming effects with the low mean instrument-years of training was not surprising. It can be inferred from the high rates of correctly predicting the hypothesis of the study that faster response times were obtained independently of explicit music knowledge. That is, individuals did no better performing the task when they understood that the two items in each trial possessed affective relationships with each. This finding suggests that perhaps the majority of the participants did not primarily use explicit strategies and that regardless of the participants' ability to develop response strategies, they failed to do so.

The goal of Experiment 3 was to observe affective priming within a semantic judgment task, deciding whether a target item is real or artificial rather than whether it is pleasant or unpleasant. Such an effect was not reported in an earlier study (Spruyt et al., 2007). In the Spruyt et al. (2007) study, two groups of participants were tested with the same stimulus materials. The first group was asked to categorize affectively polarized target pictures of animals and objects on the basis of their valence, unless the targets were presented in the center of a rectangle. In that case, participants were instructed to categorize the targets as objects or animals. In the second group, participants were asked to categorize the target pictures as referring to objects or animals, unless they were presented in the center of a rectangle. In that case, participants were asked to categorize the targets on the basis of their valence. Importantly, the targets were framed on only 25% of the trials. Thus, the affective dimension was relevant more often than nonaffective semantic dimensions in the first group (hereafter referred to as the 75% evaluation condition) whereas nonaffective semantic dimensions were relevant more often than the affective dimension in the second group (hereafter referred to as the 25% evaluation condition). In many regards, this procedure did not particularly embed affective priming within the task; rather participants were asked to make either semantic or affective evaluations based on the trial conditions.

Two conclusions from the Spruyt et al. (2007) article are relevant to Experiment 3: a) that processes operating at an encoding stage contribute to the affective priming paradigm; and b) that affective stimulus processing is reduced when participants selectively attend to nonaffective (semantic) stimulus features. The latter point suggests that emotional processing may be reduced in presence of nonaffective targets and primes, such as single notes and nonwords. The results of Spruyt et al. (2007) establish interplay between affective and nonaffective stimulus dimensions and these findings give rise to future research in which lexical access is examined with affective stimuli. Using their methodology, Spruyt et al. (2007) found a reduction in affective processing when semantic decision-making was the instructed task. It is of theoretical interest however, to examine this relationship using other methodological approaches. In the current study, individuals were asked to make a semantic decision – to decide whether the second item presented was either real (i.e., a word or a chord) or artificial (i.e., a nonword or a single musical note) and within this decision were possibilities for congruency or incongruency among words or chords (e.g., a happy word could have primed another happy word). Such a procedural design allows for the possibility of deriving congruency within a task that is effectively a semantic judgment (deciding real or artificial and not pleasant or unpleasant).

In the Word-Word condition, an affective congruency effect was observed, with a non-significant but similar trend also seen in the Chord-Chord condition. Such findings imply that affective priming can be observed within a semantically focused task. The results of the Chord-Chord condition leave open the possibility for some skepticism, however, as to the robustness of such an event in music stimuli. There is considerable evidence that minor chords provide less psychological stability of affect or emotion than major chords (Cook, 2009). The inherent "tension" of unresolved chords is among the most salient features of three-tone chords, prior to the issue of the type of modal resolution. In relation to the unresolved (e.g., diminished and augmented) "tension" chords (i.e., triads with two intervals of equal size, or their inversions), minor resolution occurs with a semitone increase in pitch and major resolution occurs with a semitone decrease. There are typically no exceptions to this pattern and, indeed, it is well known in traditional harmony theory (although normally stated in terms of the pitch decrease of minor relative to major chords, with complete omission of the "tension" chords) that diatonic scales possess such features. In the case of Experiment 3, it could have been that participants were less able to consistently attach emotion to minor chords serving as prime or target. Several studies have found major chords to be more consistently associated with happiness with minor chords possessing a trend toward negative affect, but with more overall variability (Bodner, Iancu, Gilboa, Sarel, Mazor & Amir, 2007; Cook, 2009; Crowder, 1984). Crowder (1984, p. 6) commented on the happiness of the major chord and said "the positive connotation of the major triad is thus derivative from its greater 'naturalness' in the physical nature of sound.... In a sense, we hear a major triad every time a single complex musical tone is sounded, so as the fourth through sixth partials are audible. This repeated exposure could make it the preferred mode over the minor." Such a comment suggests that perhaps a major chord simply possesses a natural connotative level of pleasantness that enables an affective component to chords out of any musical context. An older experiment by Heinlein (1928), later re-examined by Crowder, demonstrated that individual chords, played out of musical context produced conventional connotation, in that individuals chose a happy adjective word after being exposed to a major chord, in comparison to a minor chord.

Concluding Remarks

The present research used only the auditory modality in examining the affective priming effect, which differs from the vast majority of other studies. Sollberger et al. (2003) for instance, used both visual and auditory presentation while Fazio et al. (1986) presented all items visually. Furthermore, the current experiments were the first to examine the effects of different material types (i.e., words and musical melodies) across all possible affectively congruent and incongruent item pairs (i.e., Happy-Happy, Sad-Happy conditions). Also noteworthy is the finding that affective properties of words and chords can be expressed within a semantic judgment task. Experiment 3 served to broaden the concept behind the Spruyt et al. (2007) study demonstrating that the affective priming effect can be observed when embedded within a semantic priming task. The present study reviewed the research on affective priming in both language and music domains, which ignited the question of whether stimulus congruency or hedonic contrast effects facilitated priming between lexical and musical stimuli. Also examined was the question of whether affective properties of words, non words, music chords and music notes could influence judgments within a semantic judgment task. In three subsequent experiments, reliable affective priming was achieved. In each of these studies, affectively congruent pairs tended to play a role in response selection. Accordingly, the studies convincingly demonstrated that processes operating at an encoding level contribute to the affective priming effect in both language and music domains, with a recognized opportunity for further investigation to obtain more uniform results.

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Appendix A

The music priming paradigm allows for the study of musical expectations based on the listeners' tonal knowledge. Tonality is a way of organizing a musical scale so that it has a central tone or pitch. By organizing a scale in this fashion, important structural points help to establish expectation of a return to the central pitch, sometimes referred to as the tonic. Today, most discussions of tonality make reference to the diatonic (major/minor) scale (Snyder, 2000, p. 246), which consists of seven note octaves comprising five whole steps and two half steps for each octave. The two half steps are separated from each other by either two or three whole steps. This pattern ensures that, in a diatonic scale spanning more than one octave, all of the half steps are maximally separated from each other (i.e. separated by at least two whole steps). Alternative to this tonal concept is the organization of tones by chroma (Snyder, 2000, p.130). Chroma refers to any of the twelve basic pitch categories of a regular European equal-tempered pitch scale. A chromatic scale consists of several sequences of pitches that ascend or descend always by semitones. Playing black and white keys of a piano in order without leaving any out would, for example, produce such a sequence of pitches. The structure of a chromatic scale is therefore uniform throughout, unlike major and minor scales, which possess tones and semitones in particular arrangements.

Within these scale systems, a chord (i.e., three or more tones sounding simultaneously) or a note is said to be consonant when it implies stability within the context of tonal organization, and dissonant when it implies instability (Snyder, 2000, p. 137). This is not the same as the ordinary use of the words consonant and dissonant. A dissonant chord is in tension against the tonic, and implies that the music is distant from that tonic chord. Resolution is the process by which the harmonic progression moves from dissonant chords to consonant chords. Consonance and dissonance are indicative of varying relationships between notes and chords based on their tonality.

The tonal hierarchy, as described by Krumhansl and Kessler (1982) distinguishes between tones on the basis of their stability and importance relative to each other. The most stable and centralized pitch is referred to as the *tonic*. The tonic note is the first tone of the scale and usually occurs near the end of major phrase boundaries. Following the tonic are notes with relatively less stability. The third and fifth scale degrees are the most stable after the tonic, and together (with the tonic) they form the major triad chord. The tonic (I) triad is the most stable chord within the system, followed by the V (dominant chord), IV, VI, and II chords, and finally the III and VII chords. Chords outside this set are referred to as nondiatonic and are quite unstable, usually demanding a piece to return to more stable triads.

In addition to major and minor triads are those that are augmented and diminished. An augmented triad contains an augmented interval, consisting of a major third and augmented fifth above the root note (e.g., an augmented D chord consists of D, F# and A#) and has four semitones between the third and fifth, four between the root and third, and eight between the root and fifth. A diminished triad chord is a triad consisting of a minor third and a diminished fifth above the root (e.g., a diminished B chord consist of B, D and F). Both triad types are considered dissonant and unstable as they lack a tonal center and the octave is symmetrically divided (Snyder, 2000, p. 140). These hierarchies among tones and chords are used to provide varying degrees of tension and resolution at different points in time throughout a composition (Krumhansl & Kessler, 1982).

A classic study by Krumhansl and Shepard (1979) investigated the proposed tonal hierarchy in an experimental setting. The experimenters asked participants to rate how well each different tone of the chromatic scale in an octave range sounded after being played the first six tones of a seven-tone C major scale. Listeners with the greatest familiarity of tonality rated the tones appropriately with regards to the tonal hierarchy predicted by music theorists. The tonic tone was rated highest, followed by the third and fifth scale degrees, followed by the remaining diatonic degrees. These findings suggest that a perceived tonal stability exists and is facilitated by one's familiarity of tonality in Western music. Krumhansl (1979) also reported that the more stable the tone, the more closely interrelated it was to other tones within the tonal system, suggesting that tonal stability aids in judgments of pairs of tones and helps to govern their relatedness with each other.

Appendix B

RESEARCH PARTICIPANT CONSENT FORM
Music Relatedness and Semantic Priming of Emotion
James March, M.Sc Candidate
Department of Psychology
Memorial University of Newfoundland

Purpose of Research The purpose of this research is to demonstrate your ability on a series of musical/auditory tasks.

Specific Procedures to be Used You will hear a series of words and musical musical sequences. Each pairing may consist of two words, two musical sequences or a word and a musical sequence. After each pairing, please respond as quickly as you can by pressing the LEFT button if you thought the second item was HAPPY. Alternatively, if you thought the second item was SAD, please press the RIGHT button.

Duration of Participation The experiment will last approximately 30 minutes.

Benefits to the Individual None.

Risks to the Individual Minimal: The risks are no greater than those ordinarily encountered in daily life.

Compensation You will receive $9.50 per hour for participating.

Confidentiality Your name is not recorded with your data. Once your participation ends, there is no way your responses can be associated with you. The data will be retained indefinitely.

Voluntary Nature of Participation You do not have to participate in this research project. If you do agree to participate, you can withdraw your participation at any time without penalty and will be paid for your time spent, rounded up to the nearest half hour, or $8.00, whichever is greater. You can ask to have you data deleted at any time until the end of the experimental session.

The proposal for this research has been approved by the Interdisciplinary Committee on Ethics in Human Research at Memorial University. If you have ethical concerns about the research (such as the way you have been treated or your rights as a participant), you may contact the Chairperson of the ICEHR at icehr@mun.ca or by telephone at 737-8368.

I HAVE HAD THE OPPORTUNITY TO READ THIS CONSENT FORM, ASK QUESTIONS ABOUT THE RESEARCH PROJECT AND AM PREPARED TO PARTICIPATE IN THIS PROJECT.

______________________________ ____________________

Participant's Signature Date

____

Participant's Name

______________________________ ____________________

Researcher's Signature

Appendix C

Happy/pleasant and sad/unpleasant word stimuli used in Experiments 1, 2, and 3

Happy/Pleasant words	Sad/Unpleasant words
ACHIEVE	ALONE
ANGEL	ANGRY
AWESOME	BEATEN
BEAUTY	BETRAY
BRIGHT	BRIGHT
CALM	BROKEN
CARING	BURN
CARESS	CANCER
CHEER	CORRUPT
CURE	DAMAGE
CUTE	DEATH
EMBRACE	DESTROY
FAITH	DESTRUCT
FREE	DIVORCE
FREEDOM	FAILURE
FRIENDSHIP	FRIGHTEN
FUN	FEAR
FUNNY	FIGHT
GENTLE	GREED
GIFT	GRIEF
GLAD	HATE
HEAL	HOPELESS
HEAVEN	HURT
HOPE	ILLNESS
JOLLY	JAIL
JOY	KILL
KISS	MISTAKE
LAUGH	MORBID
LIGHT	MOURNFUL
LOVING	MURDER
LUCKY	NIGHTMARE
MARRIAGE	PAIN
MERRY	PRISON
MONEY	RAPE
NATURE	REGRET
PEACE	SCARRED
PLAY	SLAUGHTER
PLEASANT	SORROW
PLEASURE	STRESS
SMILE	SUFFER
SOOTHING	TEARS
SUCCESS	TERROR
SUNSHINE	TORMENT
SURVIVE	TORTURE
SWEET	VICTIM
TENDER	WAR
UPBEAT	WEAPON
WELCOME	WOUND

Appendix D

Personal information questionnaire used in Experiment 2

Subject # ______________________________

Instructions
Please check off the appropriate answers that apply to you. All responses will be collected anonymously.

Gender
Male _____ Female_____

Age (in years)
18-21_____ 22-25 _____ 26-29_____ 30 or older_____

Level of Education
High School_____ Some College_____ College Graduate_____ Some Graduate_____

What is your native language?
____

Do you speak any other languages?
Yes_____ No_____

If yes, what language(s)?
____

Are you
Right-handed? _____ Left-handed? _____

How often do you listen to music?
More than 2 hours per day_____ 1-2 hours per day_____ 4-5 hours per week_____ Less than 4-5 hours per week_____

Do you play a musical instrument?
Yes_____ No_____

If so, what type of instrument(s) do you play (check off all that apply)?
_____ Brass Instrument (e.g., tuba, trumpet)
_____ Percussion Instrument (e.g., drums, glockenspiel)
_____ String Instrument (e.g., violin, piano)
_____ Woodwind Instrument (e.g., flute, clarinet)
_____ Voice

_____ Other

How many years have you been playing your instrument?
1-3 years_____ 4-6 years_____ 7-9 years_____ 10 years or more_____

How often do you play your instrument?
Daily_____ 3-6 times a week_____ 1-2 times a week_____ _____ Rarely _____

Have you received any private training (e.g., one-on-one)?
Yes_____ No_____

If so, how many years were you privately trained?
1-3 years______ 4-6 years______ 7-9 years______ 10 years or more______

Have you ever publicly performed (check all that apply)?
Solo ______ Group ______ Orchestra _____

Have you taken any post-secondary courses in music?
Yes_____ No_____

Are you a college major studying music?
Yes_____ No_____

Do you consider yourself a musician?
Yes_____ No_____

Thank you for filling out this questionnaire.

Appendix E

Happy Melody
(example)

♩=120

Sad Melody
(example)

♩=120

Appendix F

In your own words, what did you think the experiment was about?

What do you think was our scientific question?

What was our proposed explanation for the question?

Appendix G

Nonword stimuli used in Experiment 3

Non-words
BEFIN
BENDOD
BERS
BESC
BILP
BLON
CIPED
CLABBED
FEECH
FROT
GICKER
GLAB
GREPT
KEND
LEHAVE
LENEATH
LERTH
PLOCK
SLENT
SLOND
TEFALL
TEHOLD
TRATHER
VELT