Is melodic expectancy influenced by pitch and temporal manipulations?

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Statement of Declaration

I declare that this thesis is my own account of my research and contains – as its main content work – which has not been previously submitted for a degree at any tertiary educational institution.

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"I can no other answer make, but thanks and thanks" - William Shakespeare

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Contents

Abstract

The aim of this study is to examine the effect of altering the surface structure and organisational framework of both pitch and time on expectancy ratings of melodies. The pitches and durations comprising each melody were presented either in their original order, as a reordered sequence, as a sequence with modified contour, or as a sequence with modified contour randomly reordered. 24 participants, exposed primarily to Western tonal music, provided expectancy ratings of the sequences in two selective attention conditions (attend to pitch only, or time only), and one global (attend to both pitch and time) condition (blocked). All manipulations of pitch and time influenced perceived melodic expectancy, however for both dimensions, manipulating the organisational framework was more effective than changes to the surface structure. Under selective attention conditions, the irrelevant dimension still influenced ratings but its effect size was attenuated in accordance with the instructions. Effects of pitch and time were significant for all instructional conditions. These results emphasise the importance of tonal and metric hierarchies as organisational frameworks for melodic perception, and provided a better insight of the overall contribution of both pitch and temporal dimensions in formation of musical expectancies.

Is melodic expectancy influenced by pitch and temporal manipulations?

Being abstract and multidimensional, music is an excellent modality for studying cognitive mechanisms. The perception of music involves the use of complex mental processes in processing musical stimuli into a form suited for comparison to pre-existing notions of musical structure, formed from the listener's musical background (Palmer & Krumhansl, 1990). The acquisition of musical knowledge takes place at an early age and occurs through passive exposure (Trainor & Trehub, 1994). This passive learning of musical structures assists the formation of expectations for future musical events (Justus & Bharucha, 2001). Therefore, musical expectancies influence a listener's interpretation and perception of a given piece of music (Schmuckler, 1989). In listening to a piece of music, both musically-trained and untrained listeners anticipate outcomes for pitch, time and other components in the music and such anticipation is based on existing expectations (Loui & Wessel, 2007). As such, the "what", "when" and "how" of musical events are central to musical expectancy, as expectancy guides attention towards the pitch and temporal structures of subsequent passages in the same melody (Jones, 1982).

The role of expectancy as fundamental in the processing of Western music has received much attention in research (Schmuckler, 1989; Bigand & Pineau, 1997; Schulkind, 1999). Pitch and time are two primary dimensions of music which have been subject to extensive research in music expectancy. Understanding the contributions of both pitch and time in music provides a better understanding of how musical events are encoded, interpreted and predicted by the listener. As such, the notion of pitch and time as abstract organisational frameworks in music forms the basis of most models of pitch and temporal organisation in studies of music expectancy (Palmer & Krumhansl, 1987a).

Tonal and Metric Hierarchies

In the pitch dimension, tonality is one of the most crucial organisational principles of Western music (Boltz, 1989a). Twelve pitch classes form the building blocks in Western music. These 12 pitch classes repeat cyclically over octaves, the frequencies of the pitch classes doubling with each consecutive octave (Tillmann, 2008). Tonality essentially involves the organisation of these 12 pitch classes into a single octave where a single reference pitch, called tonic, is taken and the remaining 11 pitch classes are judged in relation to this reference pitch. In this way, a hierarchical organisation is formed in which the reference pitch appears at the top and the remaining pitch classes arranged below it in terms of their order of psychological stability compared to the reference pitch (Krumhansl & Kessler, 1982). The reference pitch, together with six pitch classes ranking highest in the hierarchy, may be arranged in an ascending sequence, starting from the reference pitch, to form a scale. Scales are named after the reference pitch. The key which the scale follows dictates which pitch classes belong to the scale, and these pitch classes correspond to the seven highest ranking pitch classes in the tonal hierarchy (Trainor & Unrau, 2012).

Pitch contour, or the pattern of ups and downs in pitch classes, is dependent on knowledge of the hierarchical organisation of pitch classes and plays an important role in dictating perception of a given melody (successive pitch structure). In examining a number of folk melodies through Fourier analysis and manipulating these melodies by eliminating any rhythmic variations present, Schmuckler (2010) reported that participants' knowledge of cyclic properties of pitches, such as the circle of fifths, contributed to perception of similarities of contour in these folk melodies. In addition, the ways in which different melodic contours start and end play an important role in participants' perception of contour relations, even if similar pitch classes were used. In other words, listeners merely take into consideration the general up-down or down-up pattern involved, rather than the pitch classes constituting these melodic contours (Schmuckler, 2010). Similarly, listeners make use of more global information such as the general up-down or down-up pattern which the melody takes, in the perception of longer melodic sequences (Schmuckler, 2010).

Two central properties of a melody thus contribute to melodic perception. The first is the musical scale which the melody follows, which assists in steering and shaping the melody's contour by dictating which pitch classes are best suited to be in the melody (Dowling, 1978). The second is the melody's contour itself – which essentially characterises the pattern of ups and downs in pitch in a particular melody (Dowling, 1978). In other words, contour forms the surface structure, while the sequence in which pitch classes are arranged forms the organisational framework, in any given melody.

In the temporal dimension, meter refers to the organising of music into recurring time-based segments called measures, or bars. Each measure contains accented (strong) or unaccented (weak) beats or pulses which are equally spaced points in time (Lerdahl & Jackendoff, 1983). Beats are the most fundamental level of temporal structure in music. The number of both accented and unaccented beats is dictated by the time signature, which consists of two numbers stacked on each other. The upper number refers to how many beats are in one measure. The lower number refers to the type of beat forming the basic time piece of the measure. For example, in the time signature 4/4, the upper number – 4 – indicates there are four beats in one measure. The lower number – 4 – indicates that the type of beat forming the basic time piece is the crotchet (quarter note) beat. Hence 4/4 means there are four crotchet beats per measure.

In a metrical pattern, a metric hierarchy is present as a complex abstraction in the temporal dimension of music (Palmer & Krumhansl, 1990). Within this hierarchy, there are three metric levels – beat, division and multiple. The beat level is the metric level where pulses are heard as the basic time unit of the music piece. Division levels refer to the metric levels where the pulses are faster than the beat level. Multiple levels refer to the metric levels where the pulses are slower. For example, if the beat level is a crotchet, a quaver (eighth note) belongs to a division level, and a minim (half note) belongs to a multiple level. Hence, in a piece of Western music, variation in metric stability exists for the different temporal positions and these variations are grouped into metric hierarchies based on their psychological stability, in the same way variations in tonal stability are grouped in the pitch dimension (Palmer & Krumhansl, 1990).

Like the pitch dimension, two central properties in the temporal dimension contribute to perception of meter. The first involves rhythmic contour – which essentially characterises the patterns of note durations involved (Lerdahl & Jackendoff, 1983). The second involves the metric context in which these note durations are arranged, and this constitutes a consistent, repetitive pattern of accented and unaccented points in time (Lerdahl & Jackendoff, 1983). Accordingly, in any given melody, contour forms the surface structure, while the sequence in which note durations are arranged in relation to an existing metric context forms the organisational framework.

The pitch dimension is generally more complex and varied than the temporal dimension, as the pitch dimension consists of 12 different pitches that potentially culminates in a variety of combinations in both melodies and chords, while the temporal dimension typically consist of either binary or ternary values and hence has more limited variation (Prince, Schmuckler & Thompson, 2009a). Consequently, pitch is more salient than time as more attention is automatically drawn towards pitch than time in the perception of Western tonal music (Prince *et.al.*, 2009a).

The role of pitch in musical expectancy

The structured complexity of pitch may be the reason for its dominance in Western music (Prince, 2011). Melody and harmony are two aspects of pitch structure in Western music. Melody refers to successive pitch structure while harmony refers to simultaneous pitch structure (Trainor & Trehub, 1994). Melody and harmony are not independent as an implied harmony is considered to be present in every melody (Bharucha, 1984).

Bharucha (1987) proposed that the musical spreading activation model, which represents the harmony of Western music as a network of interconnected units, may be used to explain the facilitation of expectancy formation in the pitch dimension. The model purports that the interconnected units are organised in three layers. Tones (pitches) form the lowest level, while keys form the highest level. Each tone is linked to a key and some tones are more strongly linked than others. In between these levels are chords, which consist of a group of pitches in vertical organisation. The playing of a chord results in activation of the network via both a bottom-up and a top-down process until equilibrium is reached. This pattern of activation reflects tonal hierarchy and also considers key-memberships of a chord (Bharucha, 1987).

Schmuckler (1989) conducted four experiments to investigate the formation of expectancies in musically trained listeners and performers. The results of the study showed that musical expectancy is a dynamic and continual process, where melodic and harmonic information are independently processed and vary in importance. Expectancies may be determined by either melody or harmony at some point, but at other points, both melody and harmony are important for expectancy formation.

In support of the study by Schmuckler highlighted above, Bigand and Pineau (1997) provided additional evidence on expectancy as a continuous process involving the interdependent relationship between a listener's musical experiences and the particular music context concerned. Within a musical structure, a local context refers to individual musical events that are situated adjacent to a given target without considering other musical events, while a global context involves a series of musical events grouped together to form a coherent musical phrase. Different harmonic contexts were found to influence different expectancies in both processing of chords and processing of melodies (Bigand & Pineau, 1997). A musical event that was more harmonically related to its global context produced higher processing speeds and higher ratings of expectancy (Bigand, Mandurell, Tillmann & Pineau, 1999). Thus, longer musical sequences facilitate better judgements of expectancy of target musical events, as they provide more substantial information than shorter musical sequences, through additive accumulation of expectancies as the musical sequence progresses (Bigand *et.al.,* 1999).

The role of time in musical expectancy

Meter plays the main function of rhythmic organisation in Western music (Palmer & Krumhansl, 1990). Rhythmic organisation or rhythm refers to the serial pattern of variable note durations in the melody of a piece of music (Schulkind, 1999). The presence of a rhythmic context in the temporal dimension enables active shifting of attention to relevant spatial and temporal aspects of the musical sequence (Trainor & Unrau, 2012), hence a diversion of attention to specific events in the pitch dimension (Jones, 1982). The presence of a rhythmic context is thus said to establish expectations in pitch, space and time.

Boltz (1993) employed the strategy of varying the temporal accentuation within the melody's initial context to assess the influences of temporal and melodic structure of a melody on the generation of expectancies. The findings showed that the temporal structure of a melody was the more important dimension as it is the vehicle that drives the listener's attention throughout the melody (Boltz, 1993).

The effects of harmony and rhythm on expectancy formation was investigated by Schmuckler and Boltz (1994). They reported that listeners' perception of a final harmonic event was simultaneously affected by harmonic and rhythmic information, emphasising the role of rhythm in musical expectancies. Schulkind (1999), however, examined the role of rhythm in long-term memory for temporal structure in music. Participants' identification of performance of songs which were subjected to several rhythmic alterations was studied and results showed that the more features that were altered by a given rhythmic manipulation, the more unlikely the listeners were to identify the song, thus indicating that temporal information is maintained in long term memory which in turn plays a role in music expectancy.

Relationship between Pitch and Time

Pitch-time integration refers to the way pitch and time contribute to, and combine in, an individual's internal perception of music (Prince, 2011). Pitch-time integration has been quite extensively studied, with some taking the position that pitch and time are independent (Palmer & Krumhansl, 1987), and others emphasising that they are interactive (Jones, Johnston & Puente, 2006; Schmuckler, 2010).

By manipulating a single-lined melody (the main theme of J.S. Bach's A minor fugue from Book 1 of The Well Tempered Clavier) through preserving the structure of pitch and/or temporal conditions, Palmer and Krumhansl (1987a) reported that pitch and temporal structures work additively to predict judgements of melodic phrase goodness. Palmer and Krumhansl (1987b) subsequently applied the same phrase manipulation to the exposition of a Mozart sonata (Sonata in A Major K331), and found that even with the presence of underlying harmonic organisation, pitch and temporal structures still combined additively in the prediction of melodic phrase goodness. In other words, pitch and temporal information were processed independently in these instances.

Through using nine-tone patterns with largely uniform rhythms, Jones *et.al.* (2006) studied how participants' responded when they were required to listen for a pitch change in a given target, which could either involve pitch intervals in narrow or wide contexts, alongside rhythmically expected or unexpected probes. The results showed that participants tended to perform better with temporally-expected probes, and when told explicitly to attend to only the pitch dimension, they performed better with pitch intervals in a narrow context. Likewise, participants performed best when pitch intervals in narrow contexts were coupled with predictable rhythmic patterns. Similarly, by eliminating rhythmic information from folk melodies, Schmuckler (2010) reported that listeners were sensitive to and utilised cyclic pitch information in perceiving similarity of melodies. However, despite the pitch dimension being much more salient as a result of the removal of rhythmic information, listeners' perceiving of similarities between melodies was not enhanced. These studies hence collectively point to the importance of interactive pitch-time relationships in music perception.

In view of the contrasting findings relating to pitch-time integration, Prince (2011) suggested that pitch-time integration is neither independent nor interactive but probably varies depending on the characteristic of the music the listener hears and his focus on the different aspects of a musical sequence. Along this line of thought, a number of studies have examined the situations under which pitch and time interact, either independently or interactively.

The effects of local and global contexts on pitch-time integration was examined through a number of studies that took into consideration tonal and metric hierarchies (Bigand *et.al.*, 1999; Tillmann & Lebrun-Guillaud, 2006). Bigand *et.al.* (1999) reported an interactive relationship between harmonic and temporal information, where musical events that were harmonically-related to its global context, together with regular temporal organisation, facilitated formation of expectancy. Tillmann and Lebrun-Guillaud (2006) conducted a series of studies focusing on series related versus unrelated musical events coupled with endings that either occurred on-time, early or late, to understand how pitch and time interact in a local or global context. The interactive contribution of pitch and time was found to be essential in the formation of expectancy in global contexts but not in local contexts. As global contexts require combining both preceding and current knowledge of musical events, such tasks are likely to involve interactive processing of pitch and temporal information (Tillmann & Lebrun-Guillaud, 2006).

Attempts to reconcile the diverse findings in the literature on pitch-time integration have resulted in the proposed concepts of dimensional salience and selective attention (Prince *et.al.*, 2009a; Prince, 2011). In the context of pitch-time integration, dimensional salience involved the prominence of one dimension over another while selective attention refers to attention to either pitch or temporal dimension individually. Prince *et.al.* (2009a) examined the effects of the structural attributes of tonality and meter on pitch-time integration by having participants listen to a musical passage followed by single probe events with varied pitch classes and temporal positions. Tonal and metric hierarchies were found to contribute additively to the goodness-of-fit of probes. Pitch influenced temporal judgements but not vice versa and this influence of pitch over temporal judgement happens even when participants attempted to attend selectively to temporal information. Prince *et.al.* (2009a) concluded that the dimension of pitch is more salient and the bias attention towards pitch is attributed to the complexity of the pitch dimension as compared to the temporal dimension.

Prince *et.al.* (2009a) studied dimensional salience in the context of responses to single tones. Since complex phrases and melodies, rather than single notes, are heard in a musical experience, Prince (2011) focused his study by varying the degree of conformity to pitch and temporal structure of melodies and have participants provide goodness ratings of these melodies based on attention to pitch, time or both. Prince (2011) reported that responses of participants were always influenced by pitch and temporal manipulations and that participants were able to emphasise either dimensions when instructed to do so. As such, the effects of pitch and time were independent under selective attention conditions and interactive when both dimensions were being evaluated.

Aims and Hypotheses of Present Study

The present study aims to further examine how structural and organisational attributes of tonality and meter influence pitch-time integration in single-lined melodies. Experiments are designed to investigate whether systematically altering the surface structure and/or organisational framework of both pitch and time affects expectancy ratings of melodies. Disruption of the surface structure involves disrupting the contour within each dimension, while disruption of the organisational framework involved disrupting information on tonal and metric hierarchy in each dimension respectively. All experiments required participants, exposed primarily to Western tonal music, to provide expectancy ratings of the sequences through using two selective attention conditions (attend to pitch only, or time only), and one global (attend to both pitch and time) condition (blocked).

It is hypothesised that all manipulations of pitch and time will influence melodic expectancy. The effects of pitch and time will be significant for all attention conditions but there will be variations in the pattern of pitch-time integration under different attention conditions.

Method

Participants

There were 24 participants (13 males and 11 females) in this study. The mean age was 25.4 years (SD = 6.79). Participants had a range of formal music training in various instruments (M = 7.93, SD = 5.20).

All participants listened primarily to Western tonal music (such as classical, pop and jazz) throughout their lives. The sample consisted of students from Perth and Singapore. Recruitment of participants was done primarily through email in Singapore, through the online Psychology Subject Pool in Murdoch University in Perth, and through word-of-mouth. Participants who signed up through the Subject Pool in Murdoch University received research credit for their participation; other participants received a small bag of chocolates worth about $7, for participation.

Materials

Forty-eight unique melodies were obtained from a sight singing book (Berkowitz, Fontrier & Kraft, 1997). Each melody was split into approximately half, depending on the phrasing of the melody so as to ensure all phrases remained intact following splitting. The first part of every melody remained unchanged. For the second part, 16 variants were created based on simultaneous alterations of pitch and temporal dimensions, which were done by either changing the organisational and/or surface frameworks within each dimension. With 16 variations of the second part of each melody, a total of 768 melodies were created. Each variant could have a change in pitch, time or both.

Melodies were presented in the data-analysis specific fourth-generation programming language MatLab7 on a PC computer. Sennheiser HD 280 Pro headphones were used for listening to the melodies.

Codes P1 to P4 were used for each of the manipulations in pitch, and codes T1 to T4 were used for each of the manipulations in time. The 16 possible manipulations to each of the 48 melodies are represented based on different combinations in these codes. For example, P1T1 refers to an original melody with no manipulations in either dimension and P2T2 refers to a melody with reordered pitches and reordered note durations.

For the pitch dimension, “Original” (P1) refers to the original sequence of pitches. “Reordered Pitch” (P2) involves randomly reordering the sequence of pitches in the melody in order to disrupt the melody’s contour. No pitches were modified to be higher or lower. “Atonal Contour” (P3) involved transposing up or down the original pitches in varying levels, creating a new set of pitches. These new pitches did not belong to any particular key, but were designed to correlate highly in tonal terms with the original pitches ($r \geq 0.8$). The contour of the new pitch sequence was kept almost identical to that of the original pitch sequence, so as to preserve the contour of the original pitch sequence as much as possible. As such, tonality was altered in the “Atonal Contour” manipulation, but the contour in which the pitches followed was retained. Lastly, in the “Atonal Random” (P4) manipulation, the sequence of pitches modified in the “Atonal Contour” manipulation was randomly reordered, disrupting the contour of the pitch sequence and modifying the tonality of each pitch simultaneously. This is a combination of the “Atonal Contour” and “Reordered Pitch” manipulation.

Likewise, for the temporal dimension, “Original” (T1) refers to the original note durations used. In the “Reordered” manipulation (T2), the sequence of note durations was rearranged with all note durations being kept identical. Essentially, the time value of each note was randomly reassigned to another note. In creating the “Ametric Contour” (T3) manipulation, the durations of each individual note were first identified. All the note durations were conventional note durations found in Western tonal music, such as crotchets (1/4), quavers (1/8) and semiquavers (1/16). For each of the unique note durations, new note durations were generated either by lengthening or shortening the original note duration. These new note durations do not map onto the conventional note durations. The degree of lengthening or shortening of the original note durations was kept within a range that ensured a high correlation between the original and the new note durations ($r \geq 0.8$). Finally, these new note durations were used in place of the original ones. The sequence of new note durations after replacing the originals was kept identical, although replacements for the same note duration were not necessarily identical in length. In other words, the metric framework of the original melody was preserved as much as possible, but the actual time values of the notes within the melody were manipulated. Lastly, in the “Ametric Random” (T4) manipulation, the sequence of durations in the “Ametric Contour” manipulation was randomly reordered, disrupting the contour of the note durations and modifying the individual note durations simultaneously. This is a combination of the “Ametric Contour” and “Reordered” manipulations.

Table 1 below illustrates and summarises the details of the manipulations of melodies while Figure 1 shows some of the melodies involved, with their respective manipulations.

Table 1.

Illustration of variants in the melodies

Temporal manipulations (T1 to T4)	Pitch manipulations (P1 to P4)			
	Original (**P1**)	Reordered (**P2**)	Atonal Contour (**P3**)	Atonal Random (**P4**)
Original (**T1**)	P1T1	P2T1	P3T1	P4T1
Reordered (**T2**)	P1T2	P2T2	P3T2	P4T2
Serial contour (**T3**)	P1T3	P2T3	P3T3	P4T3
Random (**T4**)	P1T4	P2T4	P3T4	P4T4

Figure 1. Illustrated examples of pitch and temporal manipulations in the melodies.

As shown in Figure 1 above, the first melody – represented by P1T1 – indicates that no manipulations were carried out in the pitch or temporal dimensions. In the second melody (P2T3), the “Reordered Pitch” and “Ametric Contour” manipulations were used in the second part. Likewise, in the melody labelled P3T4, the second part of the melody involved the “Atonal Contour” and “Ametric Random” manipulations, while in the melody labelled P4T2, the second part of the melody involved the “Atonal Random” and “Reordered Time” manipulations.

In summary, the manipulations were created based on either preserving or altering the surface structure as well as the organisational framework of the melodies. For the “Reordered” manipulations in both pitch and time, the surface structure was altered while the organisational framework was maintained, for the “Atonal contour” and “Serial contour” manipulations, the organisational framework was altered while the surface structure was maintained, and for each of the “Random” manipulations in pitch and time, both the surface structure and organisational framework of the melodies were altered.

Three instruction conditions – “rate based on pitch only”, “rate based on time only” and “rate based on both pitch and time” were also formulated. Each instruction condition consisted of 64 trials which used all the 16 variant levels sampled from the 768 melodies created. Instructions were switched after 64 trials, and prior to a change in instructions, participants were informed that they will be rating the melodies based on a different dimension. The 64 trials were counterbalanced by a complex Latin squares formula such that participants do not experience a given melody four times to prevent memory effect. All variants of the melodies are heard, but not by the same participant and the order of instructions were counter balanced across participants.

Participants pressed the space bar to hear each of the trials within each instruction group and provide expectancy ratings each time. Participants rated their expectancy of the melody on a scale of 1-7, 7 being the highest expectancy. Participants rated each melody after hearing it before proceeding to the next melody.

Procedure

Participants were first given a plain language statement concerning the details of the experiment (Appendix A). They then signed a consent form (Appendix B) and filled in a background questionnaire assessing their experience listening to and performing music (Appendix C).

Participants did six practice trials, where instructions on which dimension to attend to (pitch, time or both) was changed every other trial. The practice rounds familiarised the participants with the experimental procedure, and provided opportunities to clarify any queries with the experimenter, who remained in the room at this time. Following the practice round, the participants then proceeded to do the actual experiment. The experimenter was not in the room throughout the duration of the experiment. The order of the instructions in the full experiment was the same as that of the practice rounds. The entire experiment, including briefing and the actual experiment, took about 1 hour.

After the experiment, participants were debriefed, to inform them of the purpose of the experiment and experimental design, as well as answer any questions.

Results

Mean expectancy ratings were calculated across the melodies. Since there were 16 different manipulations in each of the three instruction conditions, 48 data points were obtained per participant. Participants' expectancy ratings were averaged across repetitions of each manipulation; the average inter-subject correlation for the data was 0.551 (SD = 0.118), indicating that there were moderately reasonable levels of agreement amongst all participants.

The effects of pitch, time and instructions on expectancy ratings were examined using a 3(instructions) x 4(pitch) x 4(time) analysis of variance (ANOVA). Mauchly's test of sphericity showed violations of sphericity in the data for main effects of pitch and time, as well as the interactions between pitch and instructions and time and instructions. As such, the Greenhouse-Geisser correction was used for these cases.

The 3(instructions) x 4(pitch) x 4(time) ANOVA revealed a significant main effect of pitch ($F\ (1.45, 33.4) = 157.00$, $p<.001$, $\eta^2 = 0.296$) and time ($F\ (1.37, 31.5) = 76.7$, $p<.001$, $\eta^2 = 0.226$) but the main effect of instructions was not significant ($F(2, 46) <1$, *ns*, $\eta^2 = 0.002$). These findings show that manipulations of pitch and time influenced perceived melodic expectancy while instructional conditions have no effect on perceived melodic expectancy.

Rate based on pitch only

The 4(pitch) x 4(time) ANOVA revealed a significant main effect of pitch ($F\ (1.54, 35.4) = 362.00$, $p<.001$, $\eta^2 = 0.866$) and time ($F\ (3, 69) = 77.0$, $p<.001$, $\eta^2 = 0.184$) on expectancy ratings. These findings signify that both manipulations of pitch and time influenced perceived melodic expectancy. The effect size of pitch (η^2 = 0.866) was approximately five times larger than the effect size of time (η^2 = 0.184), indicating that participants were able to emphasise selectively, paying more attention to the pitch dimension than the temporal dimension.

A significant interaction between pitch and time (F (5.30, 122) = 104.00, p = 0.042, η^2 = 0.025) was also revealed but its effect size was very small (η^2 = 0.025). This interaction was seen under “Atonal Contour” and “Atonal Random” manipulations and was due to the effect of “Reordered Time” and “Ametric Random” manipulations only. Figure 2 below provides a graphical representation of mean expectancy ratings as a function of pitch and time manipulations.

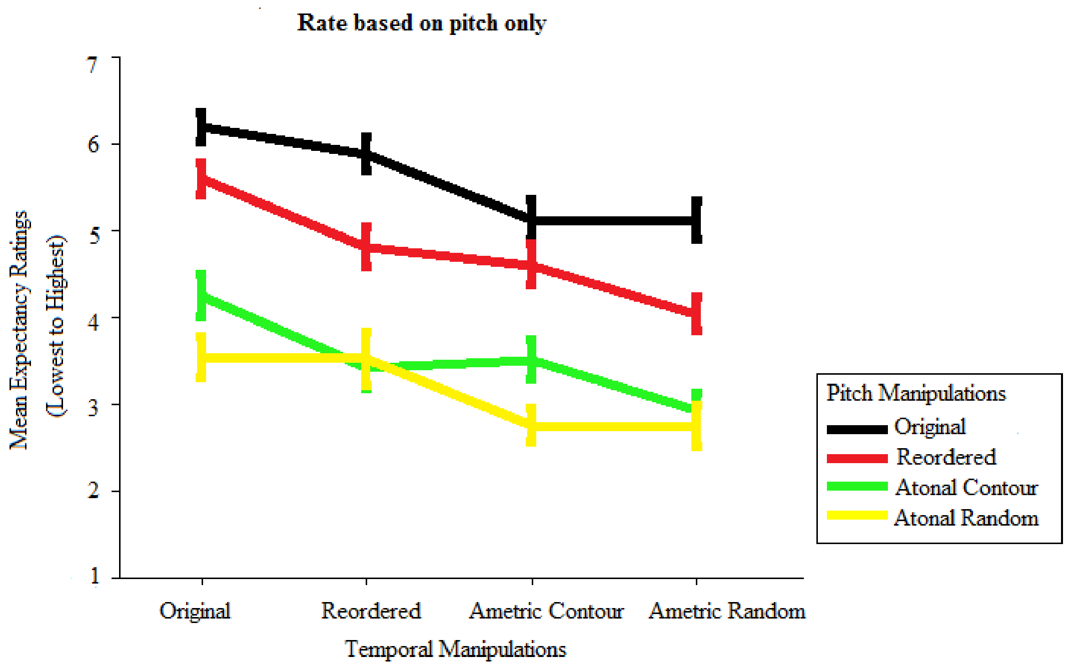

Figure 2. Mean expectancy ratings based on the instruction – “rate based on pitch only”. The error bars in the figure represent standard errors of the mean.

Pairwise comparisons indicated that in the pitch dimension, “Original Pitch” had the highest mean expectancy ratings (M = 5.57), 95% CI [5.26, 5.88], followed by “Reordered Pitch” (M = 4.75), 95% CI [4.41, 5.08], “Atonal Contour” (M = 3.52), 95% CI [3.14, 3.90] and finally, “Atonal Random” (M = 3.13), 95% CI [2.71, 3.55]. Although the differences in mean ratings between “Original Pitch”, “Reordered Pitch” and “Atonal Contour” were significant at an alpha level of 0.05, the difference between “Atonal Contour” and “Atonal Random” was not significant, but nearly so, as the mean for “Atonal Random” was outside the confidence interval range of “Atonal Contour” but not vice versa.

For the temporal dimension, pairwise comparisons revealed that the “Original Time” manipulation led to the highest mean ratings (M = 4.88), 95% CI [4.57, 5.20], followed by “Reordered Time” (M = 4.40), 95% CI [4.04, 4.76], “Ametric Contour” (M = 3.99), 95% CI [3.72, 4.26] and finally, “Ametric Random” (M = 3.69), 95% CI [3.37, 4.02]. Although the differences in mean ratings between “Original Time”, “Reordered Time” and “Ametric Contour” were significant at an alpha level of 0.05, the difference between “Ametric Contour” and “Ametric Random” was not significant, but nearly so, as the mean for “Ametric Random” was outside the confidence interval range of “Ametric Contour” but not vice versa.

Rate based on time only

The 4(pitch) x 4(time) ANOVA revealed a significant main effect of pitch ($F(3, 69) = 119.00$, $p<.001$, $\eta^2 = 0.139$) and time ($F(1.45, 33.3) = 412.00$, $p<.001$, $\eta^2 = 0.482$), signifying that both manipulations of pitch and time influenced perceived melodic expectancy. The effect size of time ($\eta^2 = 0.482$) was approximately three times larger than the effect size of pitch ($\eta^2 = 0.139$), indicating that participants were able to emphasise selectively, paying more attention to the temporal dimension than the pitch dimension. Figure 3 below highlights interaction between pitch and time under “Atonal Contour” and “Atonal Random” manipulations across all levels of time manipulations but this interaction was not significant ($F(9, 207) = 3.71$, $p = 0.458$, $\eta^2 = 0.004$), indicating that the effects of pitch did not vary across manipulations in the temporal dimension and vice versa.

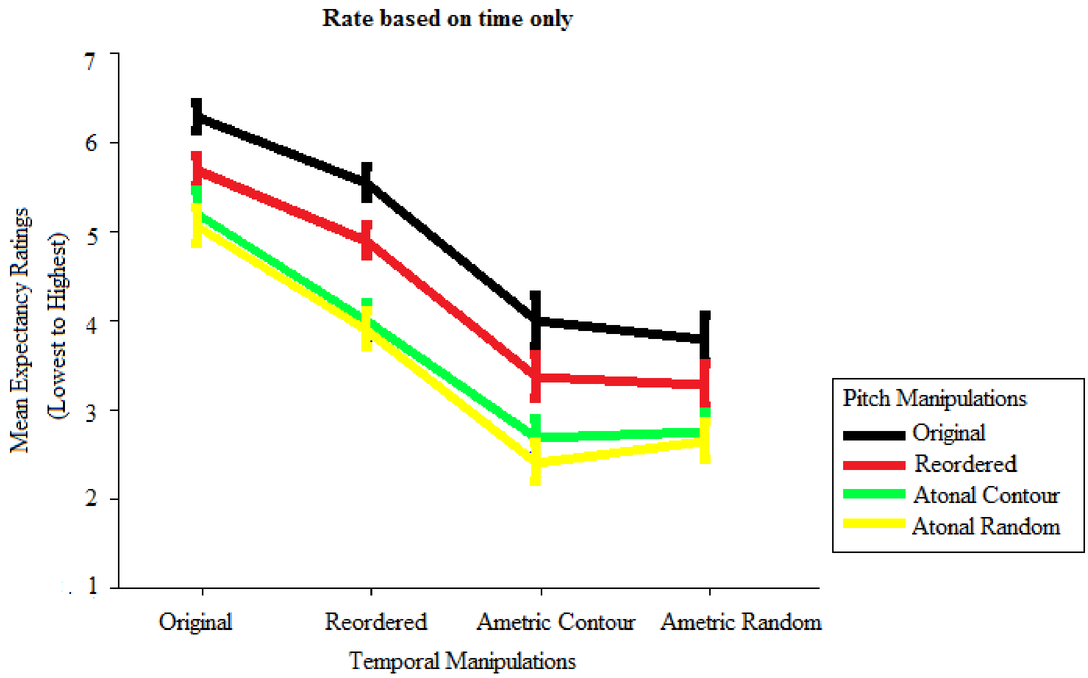

Figure 3. Mean expectancy ratings based on the instruction – “rate based on time only”. The error bars in the figure represent standard errors of the mean.

Pairwise comparisons revealed that in the pitch dimension, “Original Pitch” had the highest mean ratings ($M = 4.93$), 95% CI [4.72, 5.24], followed by “Reordered Pitch” ($M = 4.33$), 95% CI [4.05, 4.62], “Atonal Contour” ($M = 3.68$), 95% CI [3.40, 3.96] and finally, “Atonal Random” ($M = 3.53$), 95% CI [3.28, 3.79]. Although the differences between mean ratings in “Original Pitch”, “Reordered Pitch” and “Atonal Contour” were significant at an alpha level of 0.05, the difference between “Atonal Contour” and “Atonal Random” was not significant.

Pairwise comparisons for the temporal dimension showed that “Original Time” had the highest mean ratings (M = 5.58), 95% CI [5.25, 5.91], followed by “Reordered Time” (M = 4.61), 95% CI [4.33, 4.89], “Ametric Contour” (M = 3.14), 95% CI [2.74, 3.54] and finally “Ametric Random” (M = 3.14), 95% CI [2.75, 3.54]. Although the differences in mean ratings between “Original Time”, “Reordered Time” and “Ametric Contour” were significant at an alpha level of 0.05, the difference between “Ametric Contour” and “Ametric Random” was not significant.

Rate based on both pitch and time

The 4(pitch) x 4(time) ANOVA revealed significant main effects of pitch (F (1.90, 43.6) = 285.00, p<.001, η^2 = 0.417) and time (F (1.56, 35.9) = 143.00, p<.001, η^2 = 0.210) on expectancy ratings. These findings again signify that both manipulations of pitch and time influenced perceived melodic expectancy. Interestingly, although participants were instructed to pay attention to both pitch and time, the effect size of pitch (η^2 = 0.417) was about twice the effect size of time (η^2 = 0.210), indicating that pitch contributed more strongly to expectancy ratings than time. As shown in Figure 4 below, interaction between pitch and time was only seen under “Atonal Contour” and “Atonal Random” manipulations and was due to the effect of “Reordered Time”, “Ametric Contour” and “Ametric Random” manipulations only. This interaction was, however, not significant (F (9, 207) = 4.20, p = 0.337, η^2 = 0.006), indicating that the effects of pitch did not vary across manipulations in the temporal dimension and vice versa.

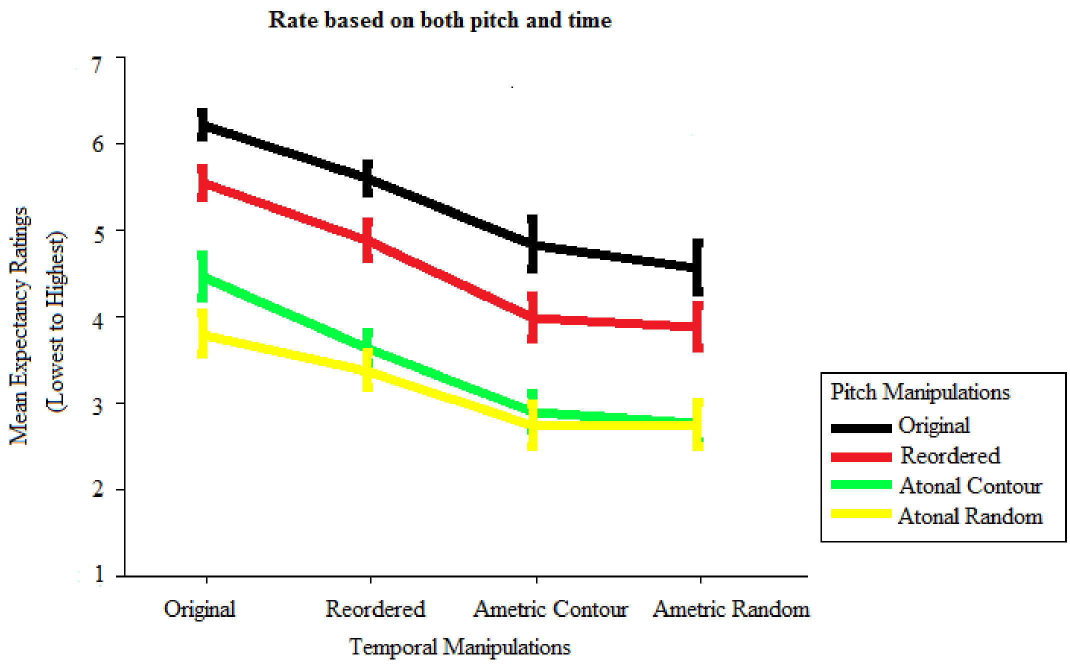

Figure 4. Mean expectancy ratings based on the instruction – "rate based on both pitch and time". The error bars in the figure represent standard errors of the mean.

Pairwise comparisons for the pitch dimension revealed that "Original Pitch" had the highest mean ratings (M = 5.27), 95% CI [4.93, 5.61], followed by "Reordered Pitch" (M = 4.54), 95% CI [4.22, 4.87], "Atonal Contour" (M = 3.41) 95% CI [3.06, 3.77], and finally, "Atonal Random" (M = 3.14), 95% CI [2.75, 3.52]. Although the differences in mean ratings between "Original Pitch, Reordered Pitch" and "Atonal Contour" were significant at an alpha level of 0.05, the difference in mean ratings between "Atonal Contour" and "Atonal Random" was not significant.

Likewise, pairwise comparisons for the temporal dimension indicated "Original Time" had the highest mean ratings (M = 4.97), 95% CI [4.68, 5.27], followed by "Reordered Time" (M = 4.34), 95% CI [4.07, 4.61], "Ametric Contour" (M = 3.58), 95% CI [3.16, 4.01] and finally, "Ametric Random" (M = 3.46), 95% CI [3.00, 3.92]. Although the differences in mean ratings between "Original Time", "Reordered Time" and "Ametric Contour" were significant at an alpha level of 0.05, the difference in mean ratings between "Ametric Contour" and "Ametric Random" was not significant.

Interactions

The 3(instructions) x 4(pitch) x 4(time) ANOVA revealed that the interactions between instructions and pitch (F (2.86, 65.9) = 5.45, p = 0.002, η^2 = 0.015), and instructions and time (F (2.99,68.7) = 10.9, p<.001, η^2 = 0.031) were significant, indicating that both the patterns of pitch and temporal effect were varied across all instructional conditions. The interaction between pitch and time (F (9, 207) = 2.06, p = 0.035, η^2 = 0.003) was, however, only marginally significant and had a very small effect size (η^2 = 0.003). The interaction between instructions, pitch and time was not significant (F (18, 414) = 1.28, p = 0.199, η^2 = 0.004), indicating that patterns of pitch and temporal effect did not vary regardless of instructional conditions.

In summary, across both pitch and temporal dimensions, "Original" always had the highest mean expectancy ratings, followed by "Reordered", "Contour" and "Random". The differences in mean expectancy ratings between "Original", "Reordered" and "Contour" were significant, but no significant difference in mean expectancy rating was observed between "Contour" and "Random". In addition, effect sizes were found to change across instructions. Under "rate based on pitch only", pitch had a much larger effect size than time (η^2 = 0.866 for the pitch dimension versus η^2 = 0.184 for the temporal dimension). Likewise, under "rate based on time only", time had a larger effect size than pitch (η^2 = 0.482 for the temporal dimension versus η^2 = 0.139 for the pitch dimension). In general, participants were able to emphasise selectively in accordance with the instructions.

However, when the instruction was to focus on both dimensions, pitch interestingly had a larger effect size than time (η^2 = 0.417 for the pitch dimension versus η^2 = 0.210 for the temporal dimension). Furthermore, both pitch and time contributed interactively to expectancy ratings only under the instruction “rate based on pitch only”. The effect size of this interaction was, however, very small (η^2 = 0.025).

Discussion

The influence of structural and organisational attributes of tonality and meter on pitch-time integration in single-lined melodies was investigated. Expectancy rating results revealed that all manipulations of pitch and time influenced perceived melodic expectancy. There were main effects of both pitch and time for all instructional conditions and these effects were in line with the structural and organisational manipulations in the melody. Across both dimensions and under all instructional conditions, mean ratings of expectancy for "Original" manipulation was highest while that for "Random" manipulation was lowest. There were significant differences between "Original", "Reordered" and "Contour" but not between "Contour" and "Random" manipulations. Under selective attention conditions, the irrelevant dimension still influenced expectancy ratings but its effect size was attenuated in accordance with the instructions. These results are further explored below.

The effect of diverting attention to the pitch and/or temporal dimensions on the formation of expectancy was first examined. When participants were required to attend to both dimensions, the pitch dimension was more effective than the temporal dimension. This was evident from the effect size of pitch being twice as large as that of time. In comparing the ratios of effect sizes of pitch to time across the instructions "rate based on pitch only" and "rate based on time only" the effect size of pitch was approximately five times that of time in the former, but in the latter, the effect size of time was only approximately three times that of pitch. These variations in effect size in accordance with instructions showed that there was selective attention failure in the temporal instruction and that it was harder to ignore pitch than time.

Results of the current study supported the concept of perpetual passive learning of the regularities of Western tonal music (Trainor & Trehub, 1994) – which has a more complex pitch dimension in relation to the temporal dimension. Perpetual passive learning of musical structures facilitates expectancy formation for future musical events encountered by participants (Justus & Bharucha, 2001). In addition, the results were in line with studies by Loui and Wessel (2007), who reiterated that in perceiving the regularities in Western tonal music, participants inevitably anticipate outcomes for pitch, time and other components, based on their existing expectations, regardless of whether musical training was involved or not. These results also accord with findings by Bigand and Pineau (1997), who advocated that musical expectancy formation was a continuous process involving the interdependent relationship between a listener's musical experiences and the musical context concerned. In other words, participants' knowledge on the regularities in Western tonal music, as well as contextual cues in a given piece of music, influenced their expectancy ratings. These results also converged with findings from Prince *et.al.* (2009a), who suggested that in Western tonal music, the presence of 12 pitches in the pitch dimension lead to diverse combinations in the formation of melodies and chords – resulting in large amounts of variation in the pitch dimension, while the temporal dimension typically constitutes either binary or ternary values, and is hence more limited in variation. As such, any given pitch will certainly have a much lower probability of occurring compared to any durations present in the temporal dimension in a melody, culminating in more attention being diverted towards the pitch dimension, at the expense of the temporal dimension.

Interestingly, participants in the present study were still able to effectively attend to the temporal dimension while ignoring the pitch dimension, in the instruction “rate based on time only”, albeit to a slightly lesser extent compared to when they were attending to the pitch dimension. As such, participants’ allocation of attention was affected by both pitch and time. The importance of temporal structure of a melody was reported by Boltz (1993) who highlighted that the temporal structure of a melody drives participants’ attention throughout the melody as it progresses, allowing a more goal-directed cognitive process in forming expectancies of the melody. The present findings also support the argument that in a given melody, alterations in the rhythmic context, or temporal dimension, subtly and consistently influences the formation of expectancies in the pitch dimension as the melody progresses (Schmuckler & Boltz, 1994). Likewise, the current findings were in line with Jones (1982), who highlighted that the presence of a rhythmic context in the temporal dimension enables active shifting or diversion of attention to specific events in the pitch dimension.

The current study also sought to investigate the relationship between pitch and time in contributing to expectancy formation, when participants were required to allocate attention towards pitch and/or temporal dimensions. Although the relationship between pitch and time appeared to be interactive in the instruction “rate based on pitch only”, the interactions were negligible in size, and were likely due to a disproportionately lower perceived expectancy for the Atonal Contour – Reordered Time combination. However, this pattern did not recur in the other two instructions and has no immediately obvious theoretical interpretation. As such, this isolated and small interaction is likely spurious; on the whole pitch and time had predominantly independent effects regardless of the presence of selective attention instructions.

Palmer and Krumhansl (1987) also suggested that pitch and temporal information are processed independently as they combined additively to predict goodness-of-fit ratings of melodic phrases. These results, however, contrasted with findings of Prince (2011), who argued that under selective attention condition, pitch and time contributed independently but when both dimensions were evaluated together, pitch and time contributed interactively. The strength of pitch-time interactions was predicted by their relative main effect sizes (Prince, 2011). These results also diverged from the findings of Tillmann and Lebrun-Guillaud (2006), whose studies on chord sequence perception showed that pitch and time typically contributed interactively during completion judgements of sequence and independently when local features of sequence were processed. Tillmann and Lebrun-Guillaud (2006) emphasised that the influence of pitch and time on chord perception is dependent on the type of processing required – local or global contexts.

The present study also investigated the effects of retaining or disrupting the surface structure (i.e. contour) and/or organisational framework within the pitch and temporal dimensions. The “Original Pitch” and “Original Time” manipulations always had the highest mean expectancy ratings as both surface structure and organisational framework were preserved, providing the highest amount of information in the formation of expectancies as compared to the other manipulations. Melodies that retained their organisational frameworks in both pitch and temporal dimensions (e.g. a melody involving “Reordered” manipulations) had higher expectancy ratings compared to melodies involving retention of organisational framework in only one dimension (e.g. a melody involving the “Atonal Contour” and “Reordered Time” manipulations). These melodies in turn had higher expectancy ratings than melodies that involved retention of surface structures in both dimensions (e.g. a melody involving “Atonal Contour” and “Ametric Contour” manipulations). In general, retention of the organisational framework (i.e.

"Reordered Pitch" and "Reordered Time" manipulations) led to higher mean expectancy ratings compared to retention of the surface structure (i.e. "Atonal Contour" and "Ametric Contour" manipulations), regardless of whether the pitch or temporal dimensions were involved, across all three instructions. These results showed that due to the presence of tonal and metric hierarchies, disrupting the organisational framework of the melody has a greater impact on the level of expectancy than disrupting the surface structure of the melody. The non-significant differences in mean ratings observed between "Atonal Contour" and "Atonal Random" manipulations was attributed to the absence of information regarding the musical scale involved in constructing the melody rather than disruption of the surface structure of the melody. Since essential information on the musical scale involved in constructing the melody was already lost, surface structure whether retained or not is no longer important.

Solely within the pitch dimension, Krumhansl and Kessler (1982) emphasised that knowledge of the musical scale, which is acquired in relation to knowledge of the tonal system, forms an essential organisational framework for the formation of any given melody. This knowledge assists in steering and shaping the contour, or pattern of ups and downs adopted by the pitch classes involved (Dowling, 1978). Likewise, Schmuckler (2010) emphasised the importance of cyclic pitch relations, or the use of equal intervals between pitch classes, in determining surface correlation of melodic contours. Such knowledge on cyclic pitch relations essentially involves knowledge of the musical scale, which in turn involves the organisational framework for the formation of any given melody. In this regard, disruption of the surface structure in the pitch dimension involved disrupting the contour of the melody, but retained knowledge of the key in which the melody was constructed, hence allowing retention of essential information on the musical scale involved. In contrast, disruption of the organisational framework led to a loss of essential information regarding the musical scale involved in arranging the pitch classes but preserved the pattern of ups and downs in this arrangement.

In the temporal dimension, the complete presence of four interdependent yet essential features – meter, phrasing, rhythmic contour and the successive ratio of durations, are important in the perception of temporal information in music (Schulkind, 1999). Meter is formed via a consistent, repetitive pattern of accented and unaccented points in time, and involves both the initial anticipation and subsequent, continuous perception of patterns of rhythm, allowing listeners' perception to be in synchrony with the progression of musical events throughout time (Lerdahl & Jackendoff, 1983). The metric hierarchy in turn involves the arranging of various rhythmic durations in a given melody, based on the stability of patterns of accents, as well as the salience and importance of these rhythmic durations in forming a rhythmic context in the melody (Palmer & Krumhansl, 1990). Arrangement of rhythmic durations based on their function in a given context, in relation to the patterns of accents and ratio of durations involved, forms the organisational framework of the melody (Lerdahl & Jackendoff, 1983). In the present study, disrupting the surface structure in the temporal dimension involved disrupting the patterns in which durations occurred, yet retaining knowledge of the the arrangement of rhythmic durations, in relation to the patterns of accents involved, and hence retaining essential information on the construction of a given rhythmic context. However, disruption of the organisational framework meant disruption of these factors, leading to a loss of knowledge about the particular rhythmic context involved.

The present study involved only participants who have been acculturated to the regularities of Western tonal music. These listeners, having been passively exposed to Western music, may have through time developed sensitivity and internalised a listening strategy to the complex organisational principles of such music (Prince, 2011). As such, it is unknown whether patterns of expectancy ratings obtained in this study could be either generalised across people acculturated to non-Western music, or to the perception of pitch and temporal dimensions in non-Western music.

A possible extension of this study could involve the comparison of participants who have been acculturated to Western tonal music, and those who have been acculturated to non-Western music. Cultures provide specific rules in pitch and temporal dimensions, causing listeners to impose their own cultural expectancies when listening to culturally unfamiliar music (Curtis & Bharucha, 2009). Musical experiences are thus interpreted differently, compared to a person who is culturally familiar with that particular piece of music. In this regard, the current study could be extended to such participants, allowing them to be exposed to pitch and temporal manipulations of Western tonal music. This allows a better insight in determining how they impose their implicit knowledge of their own musical cultures to the formation of expectancy in Western tonal music, as well as to determine if there are any similarities or differences in patterns of expectancy ratings.

Another possible extension could involve the comparison of Western tonal music with non-Western music constituting a simpler pitch dimension and a more complex temporal dimension. One such example of this includes traditional West African music from Ghana. Unlike Western tonal music, traditional West African music involves a much simpler pitch dimension constituting a five-tone pentatonic scale which does not involve an approximation of the tones in Western tonal music while its temporal dimension involves a system of complex polyrhythms and syncopations, dominated by rhythmic and percussive devices (Merriam, 1959). Future research could potentially employ a similar approach used in the current study, to include the examination of simultaneous manipulations of pitch and temporal dimensions on the formation of expectancy in West African music. It is anticipated that more attention will be diverted towards the temporal dimension, at the expense of the pitch dimension when participants are exposed to West African music. These allow a comparison on how listeners' expectancy patterns differ across music of different cultures.

With the simultaneous manipulations in the pitch and temporal dimensions, the present study supported the higher salience of pitch in relation to time, but argued that participants were able to attend to the temporal dimension effectively if required to do so. The present study also reiterated that despite simultaneous manipulations in the pitch and temporal dimensions, both pitch and time contributed independently to the formation of expectancies, regardless of whether participants were attending to either dimension, or both dimensions. In addition, the present study emphasised the importance of organisational frameworks in both the pitch and temporal dimensions. To allow cross-cultural comparison of expectancy ratings, the inclusion of participants acculturated to non-Western music was proposed, as well as the comparison of Western tonal music with non-Western music involving a more complex temporal dimension. Overall, the present study reinforced the central importance of tonal and metric hierarchies as organisational frameworks for melodic perception and provided a better insight of the overall contribution of both pitch and time in formation of musical expectancies in Western tonal music.

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Appendix A

Information Letter

Project Title: Is melodic expectancy influenced by pitch and temporal manipulation?

Investigator	Dr Jon B Prince

Contact Person	Dr Jon B Prince
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Telephone	(08)93606670

You are invited to participate in this study.

Background

When listening to music, one must mentally combine the dimensions of pitch and time. Despite the inherent complexity of this process, it occurs automatically. Understanding how pitch-time integration occurs can reveal not only how the mind creates the experience of music, but also how dimensions of any stimulus (visual, auditory, etc) combine in our perception. Previous research suggests that there are a number of factors that influence pitch-time integration, yet how exactly they work is still unclear. This research project aims to examine these factors more closely, and you are invited to participate in this process.

What Does Your Participation Involve?

In this experiment, you will listen to short auditory sequences (e.g., melodies) over headphones and then respond to some aspect of the melody. For example, you may be asked to rate how good the melody is, or how similar it is to another melody, or classify whether it fits a particular pattern. Over the course of an hour, the computer will present a number of these melodies, and you will respond to each one in turn. Responses will involve pressing a button on the computer keyboard.

It is important that you understand that your involvement is this study is voluntary. Although your participation is desired, you have the right to decline. There will be no consequences to you if you decide not to participate. If you decide to discontinue participation at any time, you may do so without providing an explanation. If you withdraw, all information you have provided will be destroyed. All information will be treated in a confidential manner, and your name will not be used in any publication arising out of the research. All of the information that you provide will be kept in a locked cabinet in a secure location.

Possible Benefits

By participating in this research, you will likely gain a deeper understanding of the procedures of scientific research, and also some knowledge of the field of music cognition in particular. There are no other expected benefits as a result of participation.

Possible Risks

There are no specific risks anticipated with participation in this study. However, if you find that you are becoming distressed or uncomfortable you may choose to discontinue your participation. Furthermore, if you feel it would be helpful then we can arrange for you to see a counsellor at no expense to you.

Questions

If you would like to discuss any aspect of this study please feel free to contact Dr Prince by email at j.prince@murdoch.edu.au or on phone extension 6670. Dr Prince would be happy to discuss any aspect of, or issue with, the research with you.

Once the information has been analysed, a summary of findings will be placed on the lab website, and in an executive summary placed on the School of Psychology website. This information should be available within one year. You are also welcome to enquire specifically (and confidentially) about your data in particular.

Thank you in advance for your assistance with this research project.

This study has been approved by the Murdoch University Human Research Ethics Committee (Approval 2012/065). If you have any reservation or complaint about the ethical conduct of this research, and wish to talk with an independent person, you may contact Murdoch University's Research Ethics Office (Tel. 08 9360 6677 (for overseas studies, +61 8 9360 6677) or e-mail ethics@murdoch.edu.au). Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.

Appendix B

Consent Form: Is melodic expectancy influenced by pitch and temporal manipulation?

1. I agree voluntarily to take part in this study.
2. I have read the Information Sheet provided and been given a full explanation of the purpose of this study, of the procedures involved and of what is expected of me. The researcher has answered all my questions and has explained the possible benefits and risks that may arise as a result of my participation in this study.
3. I have been advised of the exclusion criteria (if any) and certify that I am eligible to participate in this experiment.
4. I understand I am free to withdraw from the study at any time without needing to give any reason.
5. I understand I will not be identified in any publication arising out of this study.
6. I understand that my name and identity will be stored separately from the data, and these are accessible only to the investigators. All data provided by me will be analysed anonymously using code numbers.
7. I understand that all information provided by me is treated as confidential and will not be released by the researcher to a third party unless required to do so by law.

Signature of Participant: ____________________ Date: …..../..…../…….

Name (printed): ____________________

Signature of Investigator: ____________________ Date: ..…../…..../…….

Name (printed): ____________________

Appendix C

Background Questionnaire

For each of the questions given below, please circle where applicable.

1	Age	
2	Sex	Male / Female
3	Handedness	Right / Left
4	Is English your first language?	Yes / No
5	Have you primarily listened to tonal Western music (e.g. pop, classical, country, rock, blues, jazz, etc.) throughout your life?	Yes / No
6	What type of music do you listen to most?	
7a	Have you had formal training on a musical instrument?	Yes / No If YES, continue the questionnaire If NO, skip the rest of the questionnaire
7b	Please specify your formal musical training:	

*Note: *"Individual" means years of one-on-one private lessons; "group" means years of training with one teacher and several students simultaneously (e.g., school class).*

Instrument	Individual (years)	Group (years)	Age started – ended

8	Do you have perfect pitch?	Yes / No / Unsure
9	How many years of training in music theory have you had?	
10	Do you think of yourself as a musician?	Yes / No
11	Are you still musically active (formal or recreational activities)?	Yes / No If YES, how many hours per week (on average) do you do music? ________ If NO, how long has it been since you did musical activities? ________

Appendix D

Consent to be contacted for future experiments

If you are interested in participating in further experiments in this laboratory, please provide your contact information below. Your information will not be shared with any third party, and will not be used for any purpose other than contacting you regarding potential experimental participation.

Name:

Email:

Phone:

Expiry date of consent (optional):

**Note: expiry date means the date after which point you do not wish to be contacted*

Appendix E

Recruitment Flyer

Participate in a music research study and earn **research credit**!

In this study, you will be required to hear short melodies, rate and classify some aspects of them. This study takes 1 hour.

To participate, you must have listened mostly to Western music throughout your life, but no musical training is necessary.

For more information, please contact

melodies.plus@gmail.com

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