Perception of Melodic Similarity: Dynamic Accentuation Representation vs Contour Representation for Melodic Recognition

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I. INTRODUCTION

The perceptual recognition of melody has been a subject of study for at least the last six decades. Nevertheless, researchers and musicians alike have not yet determined the exact method that listeners use to decode melody and as a result, are unable to confirm which melodic components may be manipulated by a composer in order to influence the perception of a compositional structure.

Our primary question is as follows: do listeners use dynamic accentuation representation, in addition to other parameter representations, for melodic recognition? Furthermore, can dynamic accentuation information override other parameter representations, such as contour information, in a compositional structure? Our experiment attempts to address whether listeners use dynamic accentuation representation over contour representation for melodic recognition. The following literature review reveals some of the findings that inform our research question, hypothesis and experiment's design.

Contour information, especially in relation to a melody's length, has proven to be the most accessible and readily available component in melody processing as it remains invariable to changes in tonal framework. Findings on contour are presented in Judy Edworthy's article [1]; musician participants were required to detect interval and contour changes in transposed versions of standard melodies of 3, 5, 7, 9, 11, 13, and 15 notes.[2] Results suggested that contour information was easily recognized yet easily lost as the melody progresses over time; it is also more difficult to retain the contour of longer melodies then it is of shorter ones. These claims conform to previously reviewed experiments by Jay W. Dowling which are highlighted in the introduction of his article. **"**Although contour plays an important role in immediate recognition of novel melodies, it is less important to the recognition of melodies stored in long-term memory."[3] Since contour information is immediately lost following retrieval, Dowling suggests that it is not a reliable melodic component to test long-term melody processing.

Interval information has also been proven to be reliable for melodic recognition: "The fact that simple transposition has virtually no effect on the ease with which a melody is recognized suggests that it is perhaps the sequence of intervals between adjacent notes in a melody which carries the information."[4] While exact transposition of intervals does not effect the perception of a melody, micro alterations (+1/-1) of small intervals (seconds or thirds) greatly effect a listener's perception while micro alterations of larger intervals have little to no effect.[5] Other findings include the difficulty for listeners to identify melodies played backward. These findings were retrieved from an article by Benjamin W. White, where untransformed melodies played backward were correctly identified 35% of the time.[6]

Another study by Dowling[7] confirms that inversion, retrograde and retrograde-inversion are perceptually recognized in short-term memory. Results revealed that all three melodic transforms were recognized more then chance in the following order: 1) inversion 2) retrograde 3) retrograde-inversion. Although contour-preserved samples were judged correctly more then exact-transforms, the results were not significant enough with contour-preserving transforms rated approx. 10% higher then exact-transforms[8]. All melodies for the experiment were composed using set theory (atonal), in order to avoid scale-step representations and were only constructed with micro-intervals (never larger then a minor 3rd). Dowling used fixed rhythms so as to avoid recognition based on rhythm alone.

II. METHOD

Based on Dowling's findings and experimental design as described in his melodic transformations article[9], the current experiment attempts to test the ability of dynamic accentuation to carry perceptual information in a context which also emphasizes contour representation, especially since there was no mention of dynamic accentuation representation in the previously reviewed literature. Participants are asked to match one of two sample melody excerpts (labelled (a) and (b)) to their designated models based on melodic similarity. Our hypothesis is that participants will rate the similarity of the samples to the

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[1] Judy Edworthy, "Interval and Contour in Melody Processing", *Music Perception: An Interdisciplinary Journal* 2, no. 3 (1985): 375-88.
[2] Edworthy, 377.
[3] Jay W. Dowling, "Context Effects on Melody Recognition: Scale-Step versus Interval Representations", *Music Perception: An Interdisciplinary Journal* 3, no. 3 (1986): 282.
[4] Benjamin W White, "Recognition of Distorted Melodies", *The American Journal of Psychology* 73, no. 1 (1960): 101.
[5] White, 106.
[6] White, 105.
[7] Jay W. Dowling "Recognition of melodic transformations: Inversion, retrograde, and retrograde inversion" *Perception & Psychophysics* 12 no. 5 (1972): 420. http://dx.doi.org/10.3758/BF03205852
[8] Dowling, "Recognition of melodic transformation", 420.
[9] Dowling, 417-421.

models based on contour representation instead of on dynamic representation.

Stimuli: There are 24 standard trials (1 trial includes 1 model, 1 sample (a) and 1 sample (b)) and 4 additional decoy trials inserted to fool participants, amounting to a total of 84 musical excerpts. All excerpts were composed specifically for this experiment. In order to downplay the use of pitch representation by participants, all model melodies were constructed between pitches A3 (A below middle C) and C#5 (on treble staff) while all sample melodies were transposed up by either a major 9th, major 10th, major 11th, major 12, or major 13th with the purpose of emphasizing contour and dynamic accent profiles. A random number generator was used to determine the transposition of each individual sample.

All melodies have 8 different pitch classes and are contained within the range of a minor 7th so that participants could still identify a contour without losing the contour information overtime. Melodies were also constructed in a lyrical sense, with an even balance between smaller intervals and larger ones so as to avoid disjunct contour patterns. In addition, all excerpts were played back using a MIDI piano sound with sustain pedal at a moderately fast tempo of 160bpm per quarter note; the timbre of the MIDI piano sound with sustain pedal produces a denser sound quality in comparison to the MIDI piano sound without sustain pedal, further downplaying the definite pitch quality of the melodies.

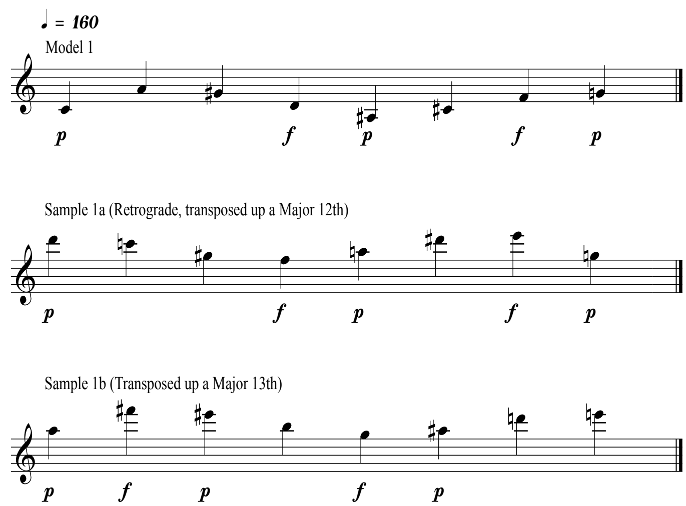
There are 2-3 dynamic accents per model. All dynamic accents use the forte dynamic, while all non-accented notes use the piano dynamic. Dynamic range is limited to forte and piano for the purpose of facilitating the perception of accent placements, especially as they are being played through MIDI. A random number generator was used (between numbers 1-4) to determine which pitches of the model would be given a dynamic accent. All (a) samples have the same dynamic accents as the model with a different melodic contour. Melodic contour was varied through the application of either retrograde, or inversion. All (b) samples have the same contour as the model yet feature different dynamic accent placements then the model. The same random number generator was used to determine which pitches would contain dynamic accents. All decoy samples featured different contour, different dynamic accent placements from their respective models. Figure 1 shows an example of one of the standard trials.

Findings from experiments by White and Dowling confirmed that familiar melodies could be recognized by their rhythm alone. As a result, the melodies of the current experiment all feature the same fixed rhythm (all notes at a quarter note value). This not only avoids rhythmic representation by participants; fixed rhythms emphasize contour representation and dynamic accentuation representation over the recognition of the following two melodic transformations: inversion and retrograde.

Participants: Six graduate students (majoring in music theory, composition, music technology or performance) from McGill University enrolled in a music perception and cognition seminar were required to participate in this experiment as part of an in-class assignment. The musical background of each participant varied from having little to no musical training in the western classical tradition to having a thorough training at an early age.

Procedures: Participants were instructed to judge the melodic similarity between brief atonal melodies. and were told that they will hear a short melody, two variations of that melody and the initial melody once more. They were later asked to judge which melody among the variations resembles the initial melody the most. Participants were also given the approximate time that it would take to complete the experiment (15-20 min.). For every trial, participants heard the model followed by sample 1 (a or b), sample 2 (the alternative letter) and the model once again. Participants answered the trials via multiple choice selection, either choosing letter (a) or (b) after hearing the excerpts. A decoy was inserted at the beginning to stimulate participant focus. The remaining decoys were inserted at random moments before the end of the experiment. The order of presentation of the trials as well as the order of appearance of samples (a) or (b) were randomized.

Figure 1 – Example of standard trial. Model, sample (a) and sample (b).



III. RESULTS

Among the 24 trials and 4 additional decoy trials, 4 out of 6 participants selected significantly more (a) samples (same-dynamics, different contour) then (b) samples (same-contour, different dynamics). When participants selected the excerpt that corresponded to sample (a) (same-dynamics, different contour), it was labelled as “true”. Note that excerpts were randomized to create a mismatch between the multiple choice selection in the experiment, with the actual samples labelled as (a) having the same-dynamic accentuation with different contour to the model. The average per respondent was calculated based on the number of “true” answers selected (see figure 2 below). A high average meant that the participant chose more (a) sample excerpts as similar to the model in comparison to (b) samples. The overall average is 76% for all participants, which is also significant.

Figure 2 – Average per participant. Total Average in right-most column

Ps	1	2	3	4	5	6	Total
Avg. per Ps	85.0%	80.0%	95.0%	60.0%	55.0%	85.0%	76. 7%

IV. DISCUSSION

These results demonstrate that dynamic accentuations may in fact possess the ability to carry perceptual information for the recognition of a melody in a compositional structure. Our hypothesis was disproven, resulting in a successful experimentation. Whether dynamic accentuation information is more accessible and readily available than contour information is still uncertain. It is worth noting that the melodies in this experiment only featured two contour types since either the retrograde or inversion transformation was applied to (b) samples in order to create a different contour from the model. Although the results proved that participants did not chose same-contour over same-dynamics, the manipulation of contour through the use of turning points should have been used to avoid introducing a new variable into the design, as melodic transformations only vary the position or shape of the initial contour (inversions, for example, only reverse peaks into valleys, preserving the size and horizontal position of the outlines).

The timbre of the MIDI sound may also have affected the results; there is a possibility that the sound distorted the perception of the contour resulting in a clearly perception of the dynamic accentuations since there were only two variables (loud and soft). Additionally, implementing excerpts at a slower tempo may provide more information on the nature of the representations and may also confirm if the timbre had an effect of the perception of the excerpts. Finally, a confidence scale would have also provided more information on the participants' reaction to the trials.

V. REFERENCES

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