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Melodic expentacy in contemporary music composition: revising and extending the implication-realization model.

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Melodic expectancy in contemporary music composition: revising and extending the Implication-Realization model

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ABSTRACT

One of the most comprehensive theories of music expectancy is the Implication-Realization [I-R] model by E. Narmour. It postulates that events implications are determined by bottom-up and top-down expectancy processes. The I-R original version postulated five bottom-up processes, which cognitive reality has been identified. Several revisions of the model simplified it, reducing the analysis to only two processes: one in which, given a melodic interval, it is expected a following event close in register to the last tone (Pitch proximity) and other in which every interval implies change of direction, returning to the first interval tone register, being such implication more evident the higher the size of the given interval (Pitch reversal). In spite of the empirical support of the I-R reduced version, its application to the study of contemporary music composition has not been reported so far. The aim of the present research was to assess the validity of the I-R reduced version to describe bottom-up processes of melodic expectancy, present in the elaboration of the note-to-note level, during a contemporary music composition task. An experiment was run with 20 major students of music composition, who were required to compose a good continuation to 9 melodic fragments extracted from lieder by A. Webern. The first note of the composed continuation was analyzed to see if it satisfied the model's implicative criteria. Results strongly supported the I-R revised version, except for small intervals. Further data analysis led to identify that small intervals had also clear implicative direction properties. As they were not reflected in the I-R reduced version, Pitch Reversal predictor was modified in order to capture them. Reformulation succeeded in describing data, except for one small interval. A concise study of this case led to hypothesize that answers could have been influenced by higher-level expectancy processes. If the three last notes of the fragment were considered instead of just two of them, the model could efficiently predict the found responses. Overall results support the I-R revised version to describe expectancy processes at the note-to-note level and suggest the model's preliminary validity to describe expectancy processes that occur at higher levels of musical structure.

Keywords

Melodic expectancy – contemprorary music composition – Implication-Realizarion model

INTRODUCTION

The I-R model of melodic expectancy

The theoretical formulation of the model

The Implication-Realization model (Narmour 1990, 1992) states that implications of melodic events are determined by top-down and bottom-up processes of music perception, i.e. by processes through which more complex and learned information is used to asses the simpler one, and by hardwired Gestalt-like mechanisms through which simpler information is used to build-up the more complex one. Narmour hypothesized the existence of three of these mechanisms: *proximity*, *similarity*, and *common direction* - as hypothetical invariants governing the elements of *pitch*, *intervallic motion* and *registral direction*.

Briefly, the I-R model claims that given certain conditions[1] any melodic interval is perceived as being unclosed and is considered an *implicative interval* (*i-i*); because an unclosed interval sounds unfinished, the model also claims that any melodic interval that follows an *i-i* -formed by the last tone of the *i-i* and the next one- is perceived as being its counterpart and is considered the *realized interval* (*r-i*). Finally, the model posits that 1) when pitches making up the *i-i* are *proximate* in register, the *i-i* convey a relation of *similarity* and implies a *similar r-i*, i.e. a similar-sized interval with the same registral direction; and that 2) when pitches making up the *i-i* are *not proximate* in register, the *i-i* convey a relation of *differentiation* and implies a *different r-i*, i.e. a different-sized (smaller) interval and a change of registral direction. In this way the model separates the small *i-i*s (≤ 5 semitones (ST)) from the large *i-i*s (≥ 7 semitones (ST)), and asserts that the former represents *similarity* and implies continuation, while the later represents *differentiation* and implies reversal or closure[2].

The empirical testing of the model

In a seminal study using the I-R model, Krumhansl (1995) carried out three experiments to test the psychological reality of the I-R's bottom-up principles in music perception. The Gestalt-like principle of *proximity* (PR) was understood in the same way as in the original formulation, and it was hypothesized that small *r-i* are more implied than large ones; the principle which determines the size's implicative property of the *i-i* was called *intervallic difference* (ID), and the principle that determine the registral implicative property of the *i-i* was called *registral direction* (RD)[3]. The principles were tested using *probe tone* technique with different musical styles and groups of subjects. Listeners were told that they would hear fragments of melodies interrupted at the middle of a phrase -over an *i-i*-, and were instructed to rate how well the additional test tones -with which the *r-i* was conformed- continued each melodic fragment; it was expected that higher ratings were given to continuation tones that fit with the model's predictions as formalized in the principles. Despite the ID predictor was not statistically significant to describe the data of experiment 2, overall results strongly supported the I-R model. Thompson, Cuddy & Plaus (1997) also tested the I-R model, but in a melody-completion task. In their study, participants were asked to produce a melody that followed naturally the two notes (the *i-i*) given by the experimenter; the agreement between the first realized-note (*r-n*) provided by each subject and the I-R's principles was analyzed. Results strongly supported the I-R model and showed that the strongest predictor for the data was RD.

Nonetheless, other researches reported that not all three I-R's bottom-up principles were useful as originally formulated. It was observed that RD needed be modified in order to be operational for large i-i only; the RD principle was revised: according to it, now large *i-i*s imply reversals but small *i-i*s have not implicative properties of registral direction (Cuddy & Lunney 1995; Schellenberg 1996). It was also observed that some principle predictions were correlated and, for this reason, the model was redundant and could be simplified (Krumhansl 1995; Schellenberg 1996). The degree to which the I-R model could be simplified while retaining its predictive accuracy was carefully examined by Schellenberg (1996, 1997). Schellenberg (1996) observed that both PR and ID predicted that small *i-r* were more expected, and that for this reason they were correlated; this co-linearity was eliminated collapsing ID and PR in the *PR -revised-* principle, which simply states that tones are more expected as more proximate are to the last tone of the *i-i*. Finally, Schellenberg (1997) designed an I-R model whith non-redundant dimension. In its final specification the model included two bottom-up principles: *Pitch Proximity*, that was the same to the PR -revised- formulated by Schellenberg (1996); and *Pitch Reversal*, that is similar to the revised RD but adds the principle of proximity applied to the first note of a given *i-i*: *Pitch Reversal* states that all *i-i*s imply a change of direction, returning proximate to its first tone, being such implication stronger for large *i-i*s.

At this point, the two-factor I-R model designed by Schellenberg (1997) retains the three original Gestalt-like principles of pattern perception formulated by the I-R original model (Narmour 1990, 1992); nonetheless, while

[1] According to the I-R model, factors that contribute to closure (i.e., the opposite of openness) at the note-to-note level of melodic structure include 1) a rest, 2) the second note of the interval beings longer in duration than the first one, 3) the second tone of the interval fallings on a beat with stronger metrical emphasis, 4) the second tone of the interval being more stable in the established musical key, 5) a change in registral direction, and 6) a large interval followed by a smaller one. Refusal of some of the factors contributing to closure will result in an interval that is partially or completely open, i.e. partially or completely *implicative*.

[2] The *i-i* of 12 ST is considered by Narmour (1990, 1992) a special case with particular implications, and the *i-i* of 6 ST a case with ambiguous implications.

[3] Like many researchers, including Narmour himself (see Schellenberg 1996, p 77, references to personal communications by E. Narmour), Krumhansl (1995) identified five bottom-up processes embodied in Narmourean theory: *proximity* (PR), *intervallic difference* (ID), and *registral direction* (RD), but also *registral return* (RR), according to which the second tone of the *r-i* is expected to be proximate in pitch to the first tone of the *i-i*, and *closure* (CL), according to which a change of registral direction, a movement to a small sized interval, or both are expected. However, subsequent investigations indicated that RR can be considered as an application of the principle of proximity to non successive tones -since RR posits that the last tone of the *r-i* is expected to be proximate in pitch to the first one of the *i-i*- (Pearce & Wiggins 2004; Schellenberg 1997; Schellenberg et al. 2002; see also Narmour 1990). It was also reported that CL was not relevent to predict the expected melodic continuation (Cuddy & Lunney 1995; Thompson & Stainton 1998) or that it was redundant because it was correlated to the central principles of the model -i.e. PR, ID and RD (Schellenberg 1996, 1997). For these reasons, the exposition that follows in the present paper will be mainly oriented to inform relevant results of previous researches concerning the cognitive reality of the three bottom-up principles originally hypothesized by Narmour (1990, 1992): PR, ID and RD.

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proximity and *intervallic difference* were retained in a similar way as the way originally formulated (that collapsed in *Pitch Proximity*), *registral direction* was notably reformulated (it was considered a process forecasting *Pitch Reversal*). In the present paper we test the predictive power of the I-R two-factor model to describe the processes of melodic expectation involved in the composition of contemporary music, with the aim of collecting further evidence to justify the validity of its hypothesis.

AIMS

The aim of the present research was to assess the ability of the two-factor I-R model developed by Schellenberg (1997) to describe bottom-up processes of melodic expectancy present in the elaboration of the note-to-note level, during a contemporary -atonal- music composition task.

METHOD

Subjects

20 major students of music composition at the Faculty of Fine Arts (UNLP) volunteered to participate in this study. All of them had been formally studying contemporary music composition for 5 years of more. All of them also had training in keyboard playing.

Stimulus materials

9 melodic fragments taken from *lieder* by A. Webern, belonging to the pre-serial period of the composer (Op. 3, Op. 4 y Op. 15) were used; the fragments were interrupted in an internal middle point of their melodic unfoldying that fulfilled the necessary conditions to obtain an *i-i* at the note-to-note level. 8 fragments were the same that those used by Krumhansl (1995; experiment 2) and Schellenberg (1996; experiment 2); the resultant *i-is* were of ± 1ST, ± 3 ST, ± 8 ST, and ± 11 ST. The spare fragment was introduced as distractor and was discarded in later analyses; it presented an *i-i* of +6 ST[4].

Procedure

Participants were provided with the melodic fragments and were required to *continue* each melodic fragment in the way they -*as compsers*- considered more convenient to produce a *good continuation*; the notion of good continuation was defined as a *good melodic voice-leading*, in such a way that no *interruption* between the last given note and first realized note (*n.r.*) took place. The fragments written down in a score were provided one at a time in an aleatorized order different for each subject; participants were asked to write down the continuations in those scores. They were also provided with a Roland E-16 synthesizer (mode *Piano 1 -number 11-*) that help playing and listening to the fragments, and trying different continuations, thus prompting an enactive development of the compositional task. Each session lasted about 70 minutes.

RESULTS

Data analysis was restricted to the first realized note (r-n) produced by each participant for each melody. The frequency of responses for the eight target fragments was entered across a two-octave range for each *i-i*, from one octave above to one octave below of its last tone. Codification of each predictor of the two-factor I-R model was the same as that designed by Schellenberg (1997). In *Pitch Reversal* codification higher values were assigned when the predictions were satisfied: for large *i-i*s a 2.5 value was assigned when the second tone of the r-i goes back to a pitch proximate (± 2 ST) to the first one of the *i-i*, a 1 value when the r-i just changes direction of the *i-i*, and a -1 value if it does not change direction; for small *i-i*s a 1.5 value was assigned when the second tone of the *r-i* goes back to a pitch proximate (± 2 ST) to the first one of the *i-i*, and a 0 value if it does not. In *Pitch Proximity* codification lower values were assigned when the predictions were satisfied: a 0 value was assigned for *r-i*s that were 0 ST, a 1 value was assigned for *r-i*s that were 1 ST, and so on.

Analysis of responses given to target fragments. A Poisson regression was used to assess how well the two-factor model could predict the pattern of responses. Results are showed in Table 1. The overall fit of the model to the data was Pseudo R^2=.161 (N200), with both predictors being statistically significant. The model was then applied separately to the analysis of data from each group of *i-i*s, small and large. Results informed that model´s predictions were somewhat better for large *i-i*s than for small ones; additionally, it was also observed that while both predictors were statistically significant to describe the responses given to large *i-i*s, only *Pitch Proximity* was significant to explain responses given to small ones. More importantly, it was observed that for small *i-i*s the correlation between *Pitch Reversal* and the data was negative; since in *Pitch Reversal´*s codification higher values were given to combinations of *i-i* / *r-i* that satisfied predictions, it was expected that correlation with the data were positive. Summarizing, this result pointed out that the pattern of responses given to small *i-i*s tended to be in the opposite way as the one hypothesized by the two-factor I-R model, and more precisely by its *Pitch Reversal* predictor.

Table 1. Results of the Poisson regression analyses conducted to the data.

	Coef	*z*	P>|z|
Analyses of responses for the eight *i-i* (N = 200)			
Two-factor I-R Model (*Pseudo* R^2 = .161)			
Pitch Proximity	-.189	-7.66	.001
Pitch Reversal	.398	4.93	.001
Two-factor I-R Model -revised- (*Pseudo* R^2 = .176)			
Pitch Proximity	-.205	-8.08	.001
Pitch Direction	.446	5.54	.001
Analyses of responses for small *i-i* (N = 100)			
Two-factor I-R Model (*Pseudo* R^2 = .177)			
Pitch Proximity	-.244	-6.63	.001
Pitch Reversal	-.290	-1.47	(N.S.)
Two-factor I-R Model -revised- (*Pseudo* R^2 = .173)			
Pitch Proximity	-.239	-6.27	.001
Pitch Direction	.143	1.08	(N.S.)

[4] Note: + = ascendent motion; - = descendent motion.

Analyses of responses for large *i-i* (N = 100)			
Two-factor I-R Model (*Pseudo* R^2 = .219)			
Pitch Proximity	-.192	-5.47	.001
Pitch Reversal	.613	5.54	.001
Two-factor I-R Model -revised- (*Pseudo* R^2 = .219)			
Pitch Proximity	-.192	-5.47	.001
Pitch Direction	.613	5.54	.001

To asses how well the original *registral direction*'s hypothesis –of small *i-i*s implying same direction, and large ones implying reversal- describes the data, *Pitch Reversal* was modified. In accordance with Narmurean´s claims that all *i-i*s have both implicative properties for continuity and reversal whatever is the dominant one (Narmour 1990. 1992), it was theorized that small *i-i*s imply *r-i*s in the same registral direction and also, in lesser extent, a registral return to the first tone of the *i-i*; registral´s implicative properties of large *i-i*´s were theorized as in Schellenberg (1997). In this way a new predictor was designed, called *Pitch Direction* (in accordance with the original mechanism postulated by Narmour). *Pitch Direction* was coded as follows: for large *i-i*s 2.5 was assigned when the second tone of the *r-i* go back to a pitch proximate (± 2 ST) to the first one of the *i-i*, 1 when the *r-i* just changes the direction of the *i-i*, and -1 if it does not; for small *i-i*s 1 was assigned when the *r-i* continues in the same direction, 0 when the *r-i* changes direction to go back to a pitch proximate (± 2 ST) to the first one of the *i-i*, and -1 if the *r-i* simply changes the direction of the *i-i*. The revised two-factor I-R model -with *Pitch Direction* instead of *Pitch Reversal*- was used to describe the pattern of responses. The fit of the revised model to the data was somewhat better than the fit of the original one. The revised model was then applied separately to the analysis of the data from each group of *i-i*s, small and large. Since theoretically and practically large *i-i*s were defined in the same way by *Pitch Reversal* and *Pitch Direction*, results for large *i-i*s were the same as previously reported; for small *i-i*s *Pitch Direction* was not statistically significant, but since its coefficient was positive, it was considered theoretically consistent. Finally, several Poisson regressions were conducted to asses if *Pitch Reversal* or *Pitch Direction* successfully described subsets of small *i-i*s responses; while *Pitch Reversal* was not statistically significant in any case, *Pitch Direction* was if responses given to Fragment 1 ended with an *i-i* of -1 ST were eliminated ($p<.02$ –not showed in Table 1) –, suggesting that those responses were affected by another factors besides the note-to-note level of melodic implications.

To check these results -actually derived from the data itself- a reanalysis of the data from experiment 2 reported by Schellenberg (1996) was conducted. This data base was selected because, in spite of have being obtained as a result of the participant's performance of a different task, stimulus materials were the same as the samples used in the present research (the 8 target fragments). In Schellenberg (1996 -experiment 2) listeners with different musical experience rated how well a set of test tones -consisting of all chromatic tones within an octave above and below the last tone of each materials- continued the fragments. The analyses reported in our paper assessed how well the two-factor I-R model described the full averaged ratings obtained for the test tones in its original -with *Pitch Reversal*- and in its revised –with *Pitch Direction*- versions, and for small and large *i-i*s. Several standards multiple regression analyses were conducted to asses the model´s performances in each case. Results are showed in Table 2.

The fit of the revised two-factor I-R model was somewhat better than the fit of the original one –predictors were statistically significant in both cases-. Obviously, for large *i-i*s the fit of the models with either predictor was the same –both predictors were statistically significant-. Nonetheless, for small *i-i*s *Pitch Reversal* was not statistically significant and, despite it was correlated positively, its confidence interval passed across 0; on the other hand, for small *i-i*s *Pitch Direction* was statistically significant, correlating positively, and its confidence interval was positive too. Finally, it was assessed how well the two-factor model described data from Fragment 1 only –*i-i* of -1 ST; results informed that averaged ratings proceeded as expected ($p<.05$ –result not showed in Table 2-,) but not as clear as the full data obtained from small *i-i*s ($p<.006$), suggesting that this stimulus material was not fully adequate to test what it was intended for.

Table 2. Results of the standards multiple regression analyses conducted to the data from Schellenberg (1996) - Experiment 2-.

	Coef.	*t(cal)*	*P>|t|*	*95% C. Interv.*
Analysis of responses for all *i-i* (N = 200)				
Two-factor I-R Model (R^2 = .520)				
Pitch Proximity	-.199	-12,23	.001	-.23 / -.17
Pitch Reversal	.435	7,70	.001	.32 / .55
Two-factor I-R Model -revised- (R^2 = .540)				
Pitch Proximity	-.206	-12,97	.001	-.24 / -.17
Pitch Direction	.415	8,37	.001	.32 / .51
Analysis of responses for small *i-i* (N = 100)				
Two-factor I-R Model (R^2 = .553)				
Pitch Proximity	-.260	-10,02	.001	-.31 / -.21
Pitch Reversal	.085	0,50	(N.S.)	-.25 / .42
Two-factor I-R Model -revised- R^2 = .585				
Pitch Proximity	-.260	-11,13	.001	-.31 / -.21
Pitch Direction	.259	2,80	.006	.07 / .44
Analysis of responses for large *i-i* (N = 100)				
Two-factor I-R Model (R^2 = .556)				
Pitch Proximity	-.157	-7,87	.001	-.20 / -.12
Pitch Reversal	.452	8,50	.001	.35 / .56
Two-factor I-R Model -revised- (R^2 = .556)				
Pitch Proximity	-.157	-7,87	.001	-.20 / -.12
Pitch Direction	.452	8,50	.001	.35 / .56

Analysis of responses given to target fragments -revised. Looking for alternative explanations to responses given to Fragment 1 in the present research, its three last notes were considered instead of just two of them; this tone-subset is showed in Figure 1. According to the I-R model, Eb^4-G^4

forms a dyadic (two-tones) structure of +4 ST whose implications at the note-to-note level are suppressed by metric emphasis and durational cumulation. Nonetheless, the model also claims that those implications are *embodied* in the structural –cumulative- tone of the dyad (the G^4) and transferred to the next level of melodic processing. From this point of view, when $F\#^4$ follows G^4, and the *i-i* of -1 ST is formed, there is implication for descending motion on the low level (by the *i-i* G^4-$F\#^4$), but also for ascending motion in the immediate higher one (embodied on the G^4). In agreement with these hypotheses, responses given to Fragment 1 were analyzed as derived from the *i-i* of +4 ST, i.e. from the next higher level of melodic structure.

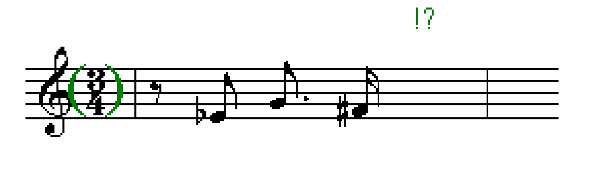

Figure 1. Last measure of Fragment 1 used in the present study and in Schellenberg (1996 -Eperiment 2)

Poisson regression analyses inform that the fit of the revised two-factor model to the data (with Fragment 1 revised) was greater than in previous analyses (*Pseudo* R^2= .214, N=200) and, more importantly, with both predictors correlated as expected and being statistically significant (p<.001 for both predictors) even for large (p<.001 for both predictors) or small (*Pitch proximity* p<.001, *Pitch Direction* p<.002) *i-i*s separately –with this data set, for small *i-i*s *Pitch Reversal* again did not reached a significance level and remained negatively correlated.

DISCUSSION

The purpose of the present research was to examine the ability of the two-factor I-R model developed by Schellenberg (1997) to describe bottom-up melodic expectancy processes involved in the note-to-note level of melodic production and, more precisely, in a contemporary music composition task.

Overall results supported the two-factor I-R model; nevertheless, the strength of its predictors was not equally successful. On the one hand, results strongly supported *Pith Proximity*, confirming previous findings according to which *proximity* is a robust or a more basic process of music cognition (Bharucha 1984; Bregman 1990; Schellenberg et al. 2002; von Hippel 2000). Nonetheless, they also informed that *Pitch Reversal* was able to predict responses given to large *i-i*s only; in fact, it was observed that responses for small *i-i*s tended to proceed in the opposite way as the one predicted by *Pitch Reversal*.

In the present research a new predictor was designed recovering the original Narmurean hypothesis of small *i-i*s implying continuation in the same registral direction, but also by retaining Schellenberg's contribution relative to the fact that all *i-i*s imply an exact or near (*proximate*) return to its first tone register. This new predictor, *Pitch Direction*, was not statistically significant to describe the full pattern of responses given to small *i-i*s, but was positively correlated with that pattern, suggesting that its formulation was theoretically correct; furthermore, *Pitch Direction* successfully explained a subset of small *i-i´*s responses – Fragment 1 removed-, while *Pitch Reversal* did not. Additional validations of the *Pitch Direction*'s hypotheses were given by reanalyzing data reported by Schellenberg (1996 –experiment 2), pointing out that this predictor was not just derived for our present data. These findings suggest that small *i-i*s actually imply the same registral direction, and are in agreement with previous findings reported by both theoretical and empirical researches on melodic expectancy (v.g. Carlsen 1981; Margulis 2005; Larson 2004; Thompson et al. 1997).

Considering the above mentioned findings, however, data collected through Fragment 1 resulted somewhat intriguing; noteworthy, reanalysis of the data from Schellenberg (1996 –experiment 2) also informed that Fragment 1 –the same here and in that research- prompted a less clearer pattern of responses, suggesting that in both cases other factors beside the note-to-note level of melodic structure could have affected the responses. In fact, since specific selection of just one tone to continue each fragment was required, it could be considered that the all-or-none quality of the task employed in the present research could have been highlighted the incidence of those factors. By considering the three last tones of the Fragment 1 -instead of just two of them- and with the Narmurean construct of *embodiment*, responses given in the present research were successfully described for both *Pitch Proximity* and *Pitch Direction*. Additionally, two other things may be observed. First, despite our interpretation of the Eb^4-G^4 as a dyad is `technically´ appropriated, the experimental test did not allow us to observe if participants actually felt the $G^4$ as metrically emphasized; so, since metric experience of this kind of music is highly `ambiguous´ (Lerdahl 1988; Meyer 1956; Pasquet 1990), we can not assert if melodic implications of Eb^4-G^4 had been suppressed through the influence of meter or remains operative instead; in any case, our interpretation that subjects responses are derived from the implicative properties of the interval Eb^4-G^4 is still correct. Second, Narmurean theory states that melodic implications of *i-i*s are suppressed on any given level once durational cumulation reaches (or exceeds) half as much length (+50%), but also states that if the point of cumulation is dissonant, only weak suppression of implication takes place and realization may occur –i.e., is still expected; we may rely on the cumulation of 50% (of the G^4) but, due the inherent dissonant quality of the atonal style (Lerdahl 1988; Schoenberg 1954 [1969]), the consonant property of the G^4 can not be asserted, suggesting that the hypothesis of Eb^4-G^4 as the *i-i* promoting the found responses would be appropriate.

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Despite these analyses, further research is needed to determine if these factors or even others (see, for example, von Hippel 2000, von Hippel & Huron 2000) may affect melodic expectancies in musical contexts as reported here.

In spite of our results, according to which small *i-i*s mainly imply continuation in the same registral direction, a lot of evidence exists supporting the opposite fact (Cuddy et al. 1995; Schellenberg 1996, 1997; Schellenberg et al. 2002; Schmuckler 1989; Thompson et al. 1998). Conjunctly considered, existent evidence on this issue suggests 1) that implicative properties of small *i-i*s are less stronger than those of large *i-i*s -as Narmour (1990, 1992) pointed out; and 2), that implicative properties of small *i-i*s are more sensitive to other factors beside those taken into account in this and others researches.

In sum, overall results supported the two factor I-R model derived by Schellenberg (1997) to describe bottom-up melodic expectancy processes engaged in contemporary music composition, but also informed that its *Pitch Reversal* predictor was not effective to describe the registral implicative properties of small *i-i*s in musical contexts as the ones we used in the present research. In fact, evidence was provided according to which the I-R model as originally formulated –with small *i-i*s implying the same registral direction- is more efficient to describe data as those here reported. Additionally, results suggest the model's preliminary validity to describe expectancy processes that occur at higher levels of musical structure. Nonetheless, due to the contradictory existent data, our findings more generally indicate that further research on this topic is needed and that a fully compressive assessment of bottom-up melodic expectancy processes proposed by Narmuor (1990, 1992) is not accomplished yet.

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