THE EFFECT OF MELODIC SYMMETRY ON NEED FOR RESOLUTION RATINGS FOR MUSICAL INTERVALS

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Abstract

The Gestalt psychologists postulated that the perception of *good* (e.g., symmetric) configurations brought equilibrium and rest to an otherwise disquieting interplay between pattern of "forces in the brain". Jairazbhoy (1971) has identified numerous instances of "melodic symmetry" in his analyses of Indian *ragas*, and has speculated that Indian listeners may have a desire to hear symmetric (or, in Gestalt parlance, *good*) *melodic* configurations. Since *good* configurations are purported to promote feelings of restfulness, it was predicted that the musical intervals associated with notes rendering melodic movements symmetrical would be given unusually low 'need for resolution' (Restlessness) ratings in the symmetric context. Ratings on a RESTFUL-RESTLESS continuum for melodic stimuli representing four types of symmetry were solicited from Indian subjects. The results generally supported the prediction, although there were indications that structurally complex instances of melodic symmetry may not be recognized. The findings were interpreted as supporting Gestalt theory, demonstrating the relevance of Gestalt principles to the understanding of musical materials, and providing a sound perceptual basis for Jairazbhoy's "need for symmetry" hypotheses.

The Gestalt school of psychology maintained that the human nervous system tends to operate on complex stimulus arrays in such a way as to organize them into maximally coherent wholes. This perceptual disposition, known as the Law of Pragnanz, was considered so fundamental that disagreeable states of heightened tension between patterns of "forces in the brain" were thought to result when the configurations, or *gestalts* abstracted from sense data were found to be less than maximally "good" (Kohler, 1940). Although nowhere in the writings of the Gestalt psychologists is there to be found a formal exposition of the distinguishing characteristics of *good* configurations, Koffka (1935, p. 110) has indicated that structural properties such as Simplicity, Regularity, and Symmetry contribute to figural goodness.

In this regard, it is interesting to note that Jairazbhoy (1971) has documented numerous instances of something he refers to as "melodic symmetry" in his analyses of North Indian classical *ragas*, and has suggested that an apparently unconscious desire on the part of the Indian listener and/or performer to hear symmetric melodic movements has been one of the factors most influential in determining the nature of the emergent melodic contours. The suggestion that there may be a desire for melodic configurations to be symmetrical—to embody one of the properties contributing to figural goodness—is clearly an acknowledgement of the same perceptual disposition that led the Gestalt school to propose the Law of Pragnanz.

But just what *is* melodic symmetry? For the present, melodic symmetry can be defined as the relationship that obtains between melodic figures (1) when the figures trace like contours when plotted against pitch vs temporal order grids, such as musical staves (Simple symmetry), (2) when condition "1" above is seen to be satisfied once one of the plotted figures has been rotated 180° (Inverted symmetry), or, (3) when condition "1" is seen to be satisfied once the plotted figures have been reflected about a common axis (Mirror-Image symmetry).

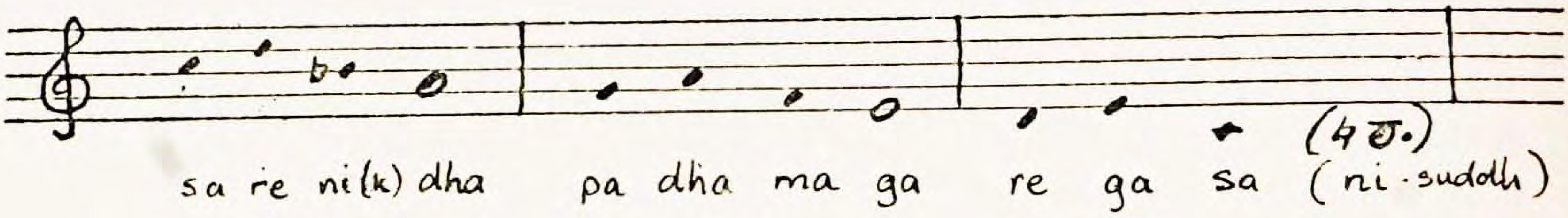
Figure 1 illustrates these three basic types of melodic symmetry, as well as one complex, composite case (Inverted Mirror-Image symmetry), resulting from a combination of rotation *and* reflection.

It was one of the aims of the experiment to be reported here to test the validity of the Gestalt notion that *good* (in this case, symmetric) melodic configurations should prove to be favoured in some way over *less* good (non-symmetric) melodic configurations. A brief elaboration of the experimental approach to be adopted follows.

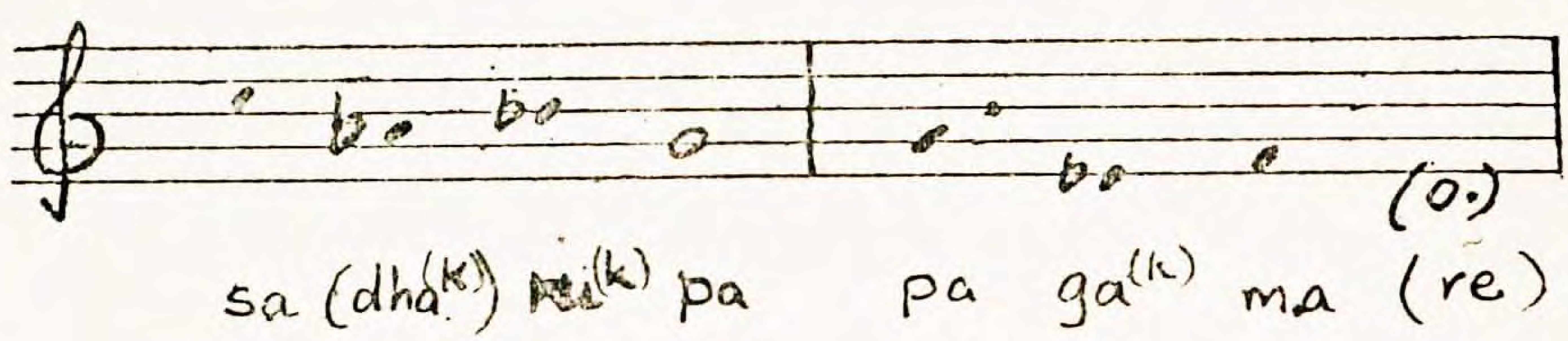
It has been repeatedly demonstrated that musical intervals, tonal dyads having slightly different component-tone vibration-frequency ratios, have widely disparate psychological effects (Kreitler & Kreitler, 1972; Maher, 1975). In musical terminology, such stimuli are said to vary along a "consonance—dissonance" dimension. Although there has been a tendency to equate consonance with pleasure and dissonance with displeasure, an examination of the literature clearly suggests that other psychological dimensions are probably more central to the phenomenon.[1] For instance, writings on dissonance characteristically describe its experiential concomitants in terms of

1 Although associations of pleasure and displeasure with such stimuli are certainly not unusual, it may be the case that the ability of a stimulus to evoke feelings of restlessness and tension is in fact responsible for its hedonic effects (Berlyne, 1971).

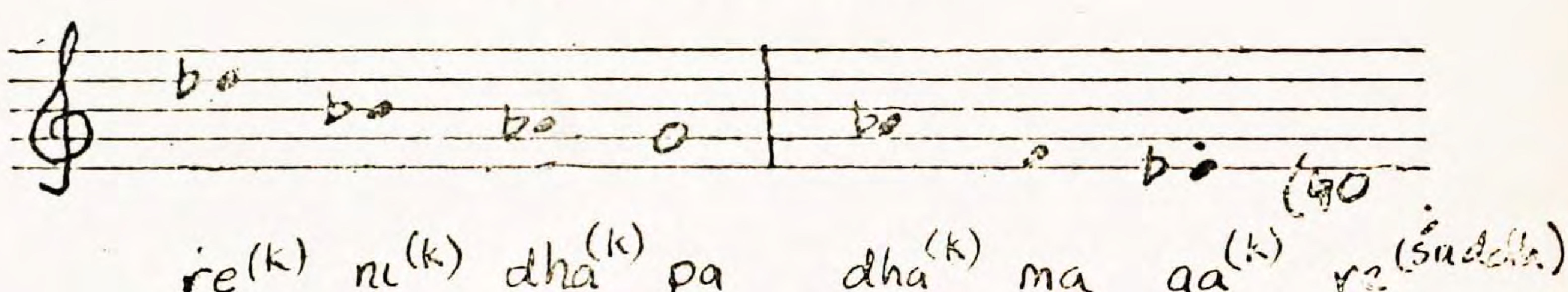
Melodic Context A



Melodic Context B



Melodic Context C



Melodic Context D

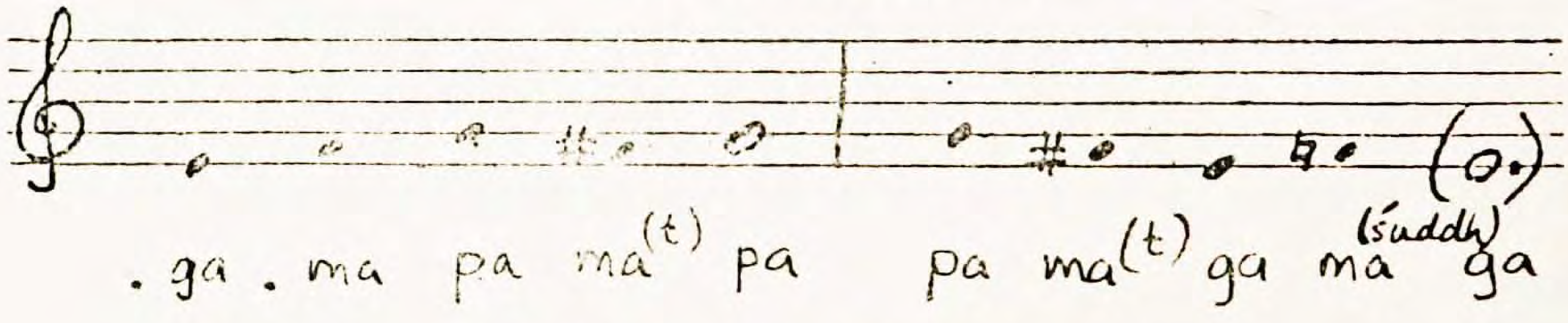


Fig. 1. Examples of four types of melodic symmetry.

"restlessness" and "tension", while consonance[is typically associated with "rest" and "relief".[2]

Research in the Gestalt tradition suggests that perception is endowed with a "striving" or "need" for the state of equilibrium that results when *bad* configurations are replaced by *good* ones (Kreitler & Kreitler, 1972, pp. 86-87). The concept of "resolution" in the theory of harmony is closely related to this notion. An interval giving rise to feelings of restlessness and tension is said to "call for a resolution"—for movement to an interval having relatively restful effects (Ammer, 1973, p. 80). Since dissonances can be conceived of as *bad* gestalts and consonances as *good* ones (Kreitler & Kreitler, 1972, p. 278), it follows that the degree of restlessness associated with a dissonance can be construed to reflect the degree to which its appearance energizes the need for the perception of a better (and therefore more restful) acoustic gestalt. Thus, a response on a RESTFUL-RESTLESS semantic differential continuum (Osgood, 1952) could be taken as an index of the capacity of an intervallic stimulus to arouse the "need for resolution" (NFR), as in Maher and Jairazbhoy (1975) and Maher (1976).

Considering Figure 1, it is evident that if phrases "A" and "B" were to be played in that order, the possibility of symmetry might be recognized by the listener before "B" had been fully executed, but it would not be *realized* until the final note of "B" had been sounded. On the assumption that the

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2 Hindemith (1952, p. 68), for example, maintained that "no musical effect can be obtained unless the *tension* between at least two different single tones has been perceived." According to Ammer (1973, p. 296), "Dissonance implies *tension*, and consonance the release of tension, or *rest*." Schoen (1940, p. 61) similarly associates "*unrest*" with dissonant chords, and Pratt (1944) associates with consonant chords *peace*, *fulfilment*, and *relief*. Cazden (1945, p. 5) summarizes the consonance-dissonance criteria of the theory of harmony, which has been called (by Kreitler & Kreitler, 1972, p. 122) the "code of rules regulating the creation of chordic *tensions* and the production of adequate *reliefs*", as follows:

> . . . the critical determinant of consonance and dissonance is expectation of movement. . . . A consonant interval is one which sounds stable and complete in itself, which does not produce a feeling of necessary movement to other tones. A dissonant interval causes a *restless expectation of resolution*, or movement to a consonant interval.

In short, dissonance is seen in Western music as representing the "element of irregularity or disturbance", and consonance "the element of normalcy and repose" (Apel, 1945, p. 18).

Similar remarks have been made with regard to the modal music of India (Jairazbhoy, 1971, p. 5):

> . . .the primary significance of the various intervals is their relationship to the ground-note. . . . Only the ground-note is at *rest* and needs no completion. All other intervals manifest instability, each to its own particular degree. . . . This quality has been described as the 'particular kind of unfulfilment peculiar to each tone, its desire for completion'.

On the basis of these remarks, Maher (1976) concluded that the association of varying degrees of restlessness with the musical intervals is a feature fundamental and common to the Western and Indian experiences alike of these elementary musical materials (N.B.: all italics in this section were added).

Indian listener and/or performer has an unconscious desire for melodic patterns to assume symmetric forms, Jairazbhoy (1971, chap. 8; 1972) has suggested that the final, symmetry-producing note in such a situation might temporarily assume a status like that of the tonic, since in that particular context it would be expected to be the most fulfilling, final-sounding, and restful of all possible notes, and thus the only one not associated with NFR[3].

Jairazbhoy's hypothesized mechanism for the modification of NFR functions of musical intervals in melodic context brings up an interesting point. Although numerous investigators in the last half-century have sought to catalogue the effects of the musical intervals by soliciting responses to *isolated* intervallic stimuli in the laboratory, there has been considerable doubt as to whether the resulting data would prove to be of much relevance to the understanding of the functions served by the same materials when in their usual, *melodic* contexts. The notion is that acoustic and temporal features local to different melodic figures can somehow impose new meanings on musical materials (Gardner & Pickford, 1943), and in doing so modify their psychological effects in unpredictable ways (Blacking, 1973; Hood, 1971).

The Law of Pragnanz, however, can provide a basis for making specific predictions about static context-to-melodic context changes in NFR functions of musical intervals. Specifically, the Gestalt psychologists might have predicted that the symmetry-producing note in a symmetric situation would be associated with an unusual degree of restfulness, since the symmetric figure it establishes would be expected to bring equilibrium to an otherwise disquieting interplay between antagonistic "forces in the brain" (Kohler, 1940). Of course, it is not necessary to subscribe to this outmoded model of brain function to come to the same conclusion. Jairazbhoy's formulation similarly predicts (1971, p. 172) that a special degree of restfulness should be associated with the symmetry-giving note in the symmetric context, since the satisfaction of the aroused "need for symmetry" should be a relieving experience.

Method

Subjects : Ninety-six female undergraduate psychology students were recruited from colleges in Poona, Maharashtra, India for participation in the experiment.

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3 Although most intervals (formed by scalar notes with the "tonic", or "ground-note") are thought to stand in need of resolution, the groundnote is considered in itself to be completely at rest, and not in need of resolution (Jairazbhoy, 1971). It should be mentioned that since Indian classical music uses a modal system, with a fixed ground-note always audible in the *drone*, there is a direct correspondence between scalar notes and the intervals (frequency-ratios) that they form in relation to the ground-note. Taking the ground-note as C, for example, the adjacent E will always be associated with the major third interval. Since a modal system was adopted for consideration in the present study, the names of the scalar notes and their associated intervals will be used interchangeably.

Stimulus Materials. Four short (12 notes maximum) melodic patterns were selected from phrases occurring in North Indian classical *ragas.*[4] Given the terminal notes depicted in Figure 2, the final portion of each melodic stimulus forms a figure symmetrical to an earlier portion. These four "melodic context" stimuli exemplify the four types of symmetry introduced in Figure 1.

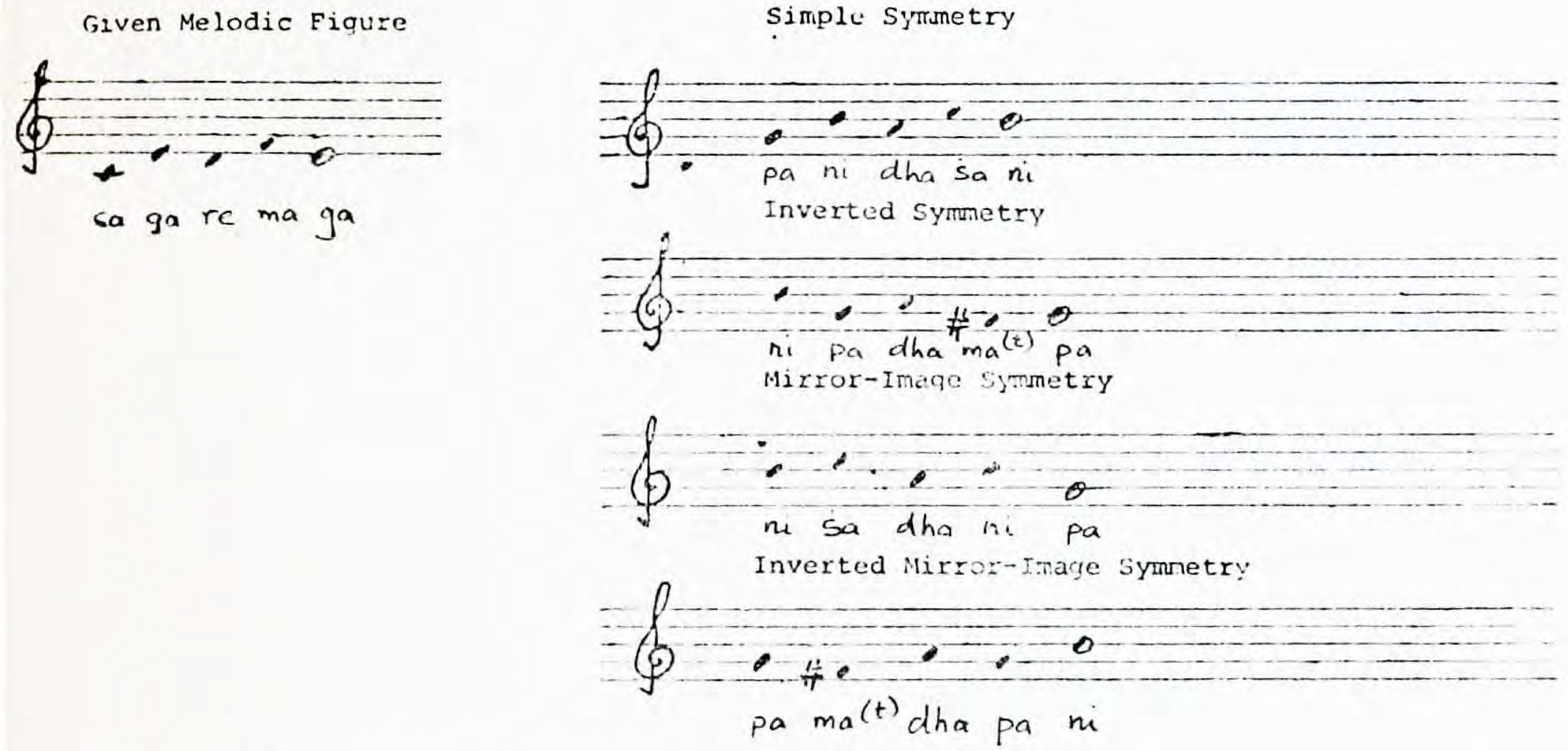

Fig. 2. Four potentially-symmetric melodic context stimuli, with symmetry-giving terminal notes shown in parenthesis. The groundnote C ottava bassa is continuously sounded for the duration of each melodic stimulus.

A Beyer M160 microphone and Nagra IV-L tape recorder were used to record the melodic materials as they were produced on an Indian harmonium, a keyboard-controlled instrument similar to the European accordion. The individual notes, which were of .1, .2, or .3 seconds in approximate duration (see Figure 2) were taken from the octave *F* (350hz) to *f* (700hz.) Rests of .3 seconds were interpolated in order to distinguish the potentially-symmetric segments from one another. The notes formed, in relation to the stop-actuated tonic of Fottave bassa (175hz.) the intervals rated for "static context" NFR by these same subjects in a previously-reported study (Maher & Jairazbhoy, 1975). For convenience, stimuli have been illustrated as if in the key of C.

Each pre-recorded melodic stimulus consisted of two previews of the basic pattern, in which the terminal note (given parenthetically in Figure 2)

4 Melodic context "A" appears on Bhatkande's (1954-9; vol. 3, p. 298) musical example of *raga* Tilak Kamod, and in a notation of an illustrative performance of this *raga* (Jairazbhoy, 1971, App. B). Melodic context "B" appears in Kaufmann's (1968, pp. 501-502) musical example of *raga* Darbari Kanada, and in an illustrative performance of *raga* Darbari (Jairazbhoy, 1971, App. B). Melodic context "C" is adapted from a musical example of *raga* Bilakkhani Tori given by Kaufmann (1968, p. 540). Melodic context "D" occurs in Kaufmann's (1968, p. 133) illustrative example of rag Bihag.

was replaced by a rest of equal duration, and one complete rendition, in which the terminal note was one of the intra-octava candidates. The "previews" were presented in order to encourage the subjects to form expectations about potential terminal notes.

Experimental design. Each of the 12 groups of eight subjects heard the four melodic stimuli in a different random order. A different randomly-determined subset of four terminal notes was assigned to each of three macro-groups of four subject-groups each, and terminal notes were assigned to contexts so that each terminal note-melodic context combination appeared once in the overall experiment.

Procedure. A few minutes after each subject-group had finished rating the individually-presented "static context" musical intervals on the 1 to 7 Shant-Asvastha (Restful-Restless) continuum (Maher & Jairazbhoy, 1975), a native speaker read the instructions for the present experiment in Marathi. Back-translated, they read as follows:

> In this section of the experiment, you will hear four sequences of notes. Each sequence will be played twice [the "previous"]. and then on the third presentation one note will be added to the sequence at the end [the "complete rendition"]. You have to record your reaction to this last note with the help of the rating scale provided for that purpose.

Results

For each of the four melodic contexts, 12 two-tailed t-tests were performed to determine whether any of the static context-to-melodic context changes in mean restlessness ratings for terminal notes was statistically reliable. Through use of Dunn's procedure (Kirk, 1968, p. 84), the probability of Type I error was maintained at .05 for each melodic context's family of 12 t-tests ($t_{.05/12,\,7}=4.21$). The significant effects and the mean ratings obtained under the static (S) and melodic (M) context conditions are reported below.

Melodic context "A". The symmetry-giving note "B", forming the major seventh interval in relation to the tonic, was rated as significantly more RESTFUL ($t=4.86$) in this context (S=5.38; M=3.62).

Melodic context "B". The symmetry-giving note "D", forming the major second interval, was rated as significantly more RESTFUL ($t=5.22$) in this context (S=6.00; M=2.12).

Melodic context "C". No statistically reliable effects emerged.

Melodic context "D". The note "F ", forming the augmented fourth interval, was rated as significantly more RESTFUL (t=4.89) in this context (S=5.88; M=2.75).

Discussion

The results for contexts "A" and "B" (Simple and Inverted symmetries) clearly demonstrate the predicted effect of melodic symmetry. Although no reliable effects emerged with context "C" (Mirror-Image symmetry), closer inspection of the data shows evidence for the predicted effect in the form of a non-significant trend; the largest restlessness reduction obtained was that for the symmetry-giving major second interval (S=6.13; M=4.63; t=3.97).

In the case of context "D" (Inverted Mirror-Image symmetry), on the other hand, the obtained results were contrary to prediction. Since this stimulus context was unique among the present collection in requiring a note of the RESTFUL class (Maher & Jairazbhoy, 1975) for the realization of symmetry, the possibility that a "floor effect" might have militated against the expected restlessness reduction must be considered. Examination of the static and melodic context means for the symmetry-giving note, however, shows that the trend was actually in the direction of *increased* restlessness (S=2.88; M=5.63; t=3.93).

It is thus apparent that the NFS hypothesis succeeds admirably in predicting the results for the first two melodic situations, but that it fares progressively more poorly with the third and fourth contexts. This situation can be understood given the following two assumptions: (1) that there exists a level of subjective complexity at which the perception of melodic symmetry is at first hindered, and then, as that level is surpassed, more or less completely impaired, and (2), that the present melodic stimuli are arranged in order of increasing subjective complexity, such that symmetry perception begins to falter with context "C".

In other words, it may be that context "D", as the most complex of the present collection, provided a symmetric *riddle* too complex for our subjects to *solve*. The symmetric problem posed by "C", on the other hand, being of intermediate complexity, was perhaps solved by only some of the subjects —hence the non-significance of the symmetry-suggestive trend. It might prove beneficial to solicit complexity ratings for melodic-symmetry stimuli in the future, so that this issue could be cleared up.

In summary, it has been demonstrated that in certain contexts, musical intervals can acquire NFR functions different from those with which they are customarily associated. This finding provides empirical support for the speculations of ethnomusicologists (Blacking(1973; Hood, 1971; Jairazbhoy, 1971; Merriam, 1964; Meyer, 1956/1974), and it adds to the scope of the psychological literature on the subjects (Gardner & Pickford, 1943; Guernsey, 1928; Heinlein, 1925; Valentine, 1962).

The finding that symmetry-giving notes were in some cases rated as more RESTFUL than usual in the symmetric context lends support to the Gestalt notion that feelings of restfulness are associated with the perception of *good* configurations, and it demonstrates the experimental utility of the music-theoretic "need for resolution" construct.

The finding that certain types of symmetric melodic figures are discriminable from their non-symmetric counterparts emphasizes the relevance of Gestalt theory to musical aesthetics (Kreitler & Kreitler, 1972), and it indicates that Jairazbhoy's (1971) "need for symmetry" hypothesis has a valid perceptual basis.

The findings with respect to structurally-complex forms of melodic symmetry, however, raise the question to what extent these complex melodic relationships, identified through analysis of musical notation (Jairazbhoy, 1971; 1972) are in fact recognized as instances of melodic symmetry by the average Indian listener.

Author's Note

The preparation of this article was facilitated by an Ontario Graduate Scholarship awarded to the senior author and by National Research Council of Canada grant No. A73 to D.E. Berlyne. The authors would like to thank Dr. Shyamala S. Vanarase of Poona's Modern College for invaluable assistance in the translation and execution of the experiment.

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