Effects of Parallelism on Meter and Grouping

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Parallelism—pattern repetition—is an important part of Fred Lerdahl and Ray Jackendoff's rhythmic theory, but they treat it only very briefly. In this essay, I offer a more rigorous account of how parallelism affects meter and grouping. Parallelism influences meter directly (though only the periods of metrical levels, not their phases); it also influences grouping directly, due to our search for an efficient encoding in which groups align with iterations of a pattern and larger groups combine successive iterations. The preference for strong beats to occur early in groups then gives rise to further, indirect effects of parallelism on meter: a tendency to hear the strongest beat early in a repeated motive, and a tendency to place the strongest beat in a series of consecutive iterations of a pattern within the first occurrence of the pattern. These effects are illustrated with examples from the common-practice repertoire.

Keywords: meter, rhythm, cognition, grouping, parallelism, Generative Theory of Tonal Music (GTTM).

Fred Lerdahl and Ray Jackendoff's *Generative Theory of Tonal Music* (*GTTM*) puts forth a conception of an "experienced listener['s]" mental representation of tonal music, comprising four components.[1] Two of the components, grouping structure and metrical structure, relate to rhythmic organization; the other two, time-span reduction and prolongational reduction, relate to pitch organization. Without doubt, it is the rhythmic components of the theory that have had the greatest impact. Lerdahl and Jackendoff's approach to meter and (to a lesser extent) grouping has had a profound influence on a wide range of studies in music theory, as well as in other fields such as music psychology, computational music research, and linguistics.[2] Terms such as metrical grid, preference rule, and phenomenal accent have become common parlance, and it is fair to say that the view of rhythm advanced in *GTTM* has become the prevailing one in music theory and psychology. Even advocates of alternative views of meter, such as William Benjamin and Christopher Hasty, have framed their approaches largely in opposition to *GTTM*.[3]

An important aspect of Lerdahl and Jackendoff's rhythmic theory is *parallelism*. Essentially, this term refers to patterns of repetition, though with a particular focus on the *effects* of repeated patterns on other aspects of musical structure. While conceding the importance of parallelism, Lerdahl and Jackendoff discuss it only briefly, writing: "Our failure to flesh out the notion of parallelism is a serious gap in our attempt to formulate a fully explicit theory of musical understanding."[4] The "fleshing out" of this idea is my aim in this essay. In what follows, I put forth a model of the rhythmic effects of parallelism that is more rigorous and precise than that found in *GTTM*. I offer a possible account of how repeated patterns are identified and how this process might affect meter and grouping, and I show that these effects can, to some extent, be attributed to more general perceptual principles. I build on earlier studies—most notably by Diana Deutsch and my own work with Christopher Bartlette—but I also discuss interactions between parallelism, meter, and grouping that have not been previously explored. Following Lerdahl and Jackendoff, my focus is on common-practice Western music; the theory's applicability to other styles is beyond my scope, though I touch on it briefly at the end of the essay.

Example 1 shows the kind of musical situation that I hope to illuminate. When I ask students if the perceived downbeats in this passage always coincide with the notated ones, they generally say they do not, and they generally agree on where the two start to misalign: on the third beat of m. 3. These "shifted bar lines" persist until the end of the first half of the movement; the beginning of the second half (not shown here) restores the notated meter. It may seem fairly apparent that this shift in meter is due, in some way, to repeated patterns, but to explain this causal process precisely proves to be a rather complex matter.

LERDAHL AND JACKENDOFF'S RHYTHMIC THEORY

The basic outlines of Lerdahl and Jackendoff's rhythmic theory are well known, and I will only review them briefly here (*GTTM* provides further detail); I also incorporate some refinements to the theory that have been proposed by others. In Lerdahl and

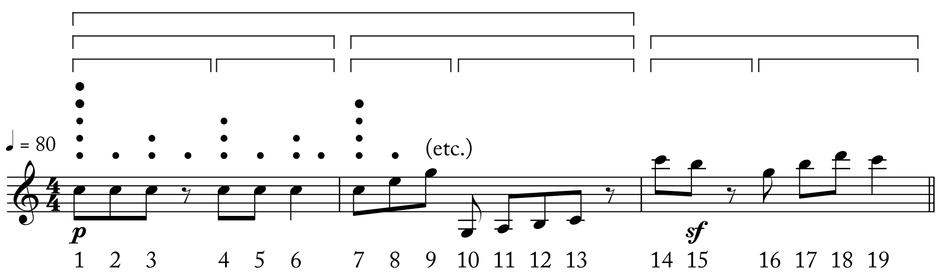
1 Lerdahl and Jackendoff (1983, 3).

2 In music theory, see monographs by Kramer (1988), Rothstein (1989), Mirka (2009), Klorman (2016), Santa (2020), and Ito (2021) (many articles could also be mentioned); in music psychology, see Deliege (1987), Palmer and Krumhansl (1990), and London (2012); in computational music research, see Temperley (2001); in linguistics, see Hayes (1995).

3 Benjamin (1984); Hasty (1997, 56–58).

4 Lerdahl and Jackendoff (1983, 53).

EXAMPLE 1. *Bach, French Suite No. 4 in E♭ Major, Allemande, mm. 1–10*

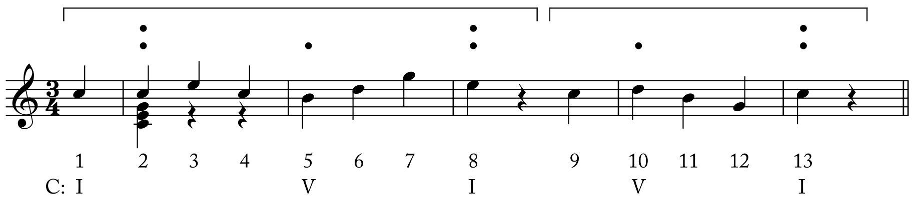


EXAMPLE 2. *A simple melody to illustrate grouping and metrical preference rules*

Jackendoff's theory, grouping structure is a hierarchical arrangement of segments—*groups*—with levels representing subphrases, phrases, periods, and sections.[5] Lerdahl and Jackendoff present a set of criteria—*grouping preference rules* (GPRs)—that govern how the listener infers a particular grouping structure for a piece out of all the possible ones. In large part, as the authors explain, the rules arise out of two basic principles of Gestalt psychology: proximity and similarity. The principle of proximity states that we tend to group together events that are close in time; thus, we tend to infer grouping boundaries at rests or after long notes, as shown in Example 2 (after notes 3 and 6, respectively). The principle of similarity states that we tend to group similar events together. In musical terms, similarity involves factors such as pitch register, dynamics, and articulation; in Example 2, the change of register after note 9 favors a grouping boundary there. (I pass over several other preference rules that will be less relevant here.) Our preferred grouping analysis is the one that best satisfies all of the preference rules taken together.[6] Points in time that are especially favored as boundaries by the preference rules—such as between notes 13 and 14, favored by both temporal proximity and pitch register—may be

5 Lerdahl and Jackendoff (1983, 36–67).

6 Lerdahl and Jackendoff focus on modeling a listener's "final understanding" of a piece—the analysis that is preferred after the entire piece has been heard. However, as several authors have shown (Jackendoff 1991; Temperley 2001, 206–14; Mirka 2009, 17–30), the theory can also model our processing of a piece as it unfolds in time; at each point, we favor the analysis that is most preferred of the portion of the piece that has been heard up to that point.



EXAMPLE 3. *A simple melody to illustrate metrical preference rules*

selected as higher-level grouping boundaries. This causes us to group the second measure in Example 2 with the first, rather than with the third. Some musical passages, like Example 2, convey a clear hierarchical grouping structure. In other cases, grouping boundaries are only weakly conveyed or even absent; the Allemande in Example 1 has a rather seamless quality, though even in that case there are subtle cues to grouping boundaries, as I will discuss.

A metrical structure, in *GTTM*'s conception, is a *metrical grid*—a framework of several levels of beats, where beats are subjectively accented timepoints in the mind of the listener; beat levels can be represented with dots, as in Example 2.[7] Lower levels of the grid generally correspond to rhythmic values implied by the time signature; there may also be levels above the measure (hypermetrical levels). Beats at higher levels are stronger—more "metrically accented." Lerdahl and Jackendoff assert that beats must be regularly spaced in time at each level, at least at intermediate levels, though they allow irregularity at hypermetrical levels and very low levels; later authors have suggested that the desire for regularity is best regarded as a preference rather than a hard-and-fast rule, even at intermediate levels.[8]

A set of metrical preference rules (MPRs) guides the listener to their preferred metrical interpretation (here again, I discuss only the most pertinent rules). Several of these rules relate to *phenomenal accents*—factors that draw attention to particular points in time. These include note onsets (as opposed to rests), onsets of relatively long notes, onsets of relatively loud notes, and (in vocal music) stressed syllables of text.[9] In Example 2, the length factor favors notes 3 and 6 as strong beats. (The perceived "length" of a note depends less on the note's literal duration than on the time interval between the note's onset and the onset of the following note—its "inter-onset interval." By this criterion, note 3 is a quarter note in length.) With regard to note onsets, a chord with several notes is more phenomenally accented than a single note.[10] Harmonic change can also be regarded as a kind of phenomenal accent; we tend to infer strong beats at the onsets of harmonies, especially relatively long harmonies. In Example 3, the chord on note 2 and the clear change of harmony on note 5 establish both notes as strong beats, creating a dotted-half-note level.[11] The listener searches for the metrical grid that best aligns beats with phenomenal accents. Phenomenal accents and metrical accents (strong beats) need not always coincide, however; a phenomenal accent may fall on a weak beat (this is the definition of syncopation), like note 15 in Example 2, and a metrical accent may be felt at a point that carries no discernible phenomenal accent, like note 11.

Grouping structure and metrical structure interact. In *GTTM*, this is reflected in one of the metrical preference rules: the "strong beat early" rule, stating that there is a preference for the strongest beat in each group to be near the beginning. In Example 2, the notes clearly group into threes (due to the greater length of notes 3 and 6), and this encourages us to hear the first note of each group as metrically strong. Similarly, we tend to hear the first measure in a large group (a piece, section, or phrase) as metrically stronger than the second; this gives rise to a "beginning accented" norm for the metrical structure of phrases. The strong-beat-early preference is fairly weak; "end accented" grouping structures (with the strongest beat occurring at or near the end of a group) certainly can arise if other cues favor them. And it seems to operate most strongly at relatively high levels of meter and grouping—that is, at fairly large time scales. In Example 2, at the tempo indicated, I tend to hear the first note as metrically stronger than the third, and even more so if the pattern were played at half speed (quarter = 40); but at double speed (quarter = 160), I might well hear the third note as stronger.

It will be helpful in what follows to treat the effect of grouping on meter as a kind of phenomenal accent—what I will call a "grouping accent." This may seem counterintuitive—partly because the effect applies not to a single point in time, like other phenomenal accents, but to a region at the beginning of a group: we might say there is a kind of "accentual envelope." This then combines with other sources of accent to single out a specific point as metrically accented. In Example 1, the beginning of the piece is surely the beginning of a group, at multiple levels (though it may be unclear where the groups end). The strong-beat-early preference then suggests that any of the first few notes of the melody may be a strong beat; it is the left-hand note that favors the second melody note above the others.

7 Lerdahl and Jackendoff (1983, 68–104).

8 Rothstein (1989, 40–43); Temperley (2001, 34–36).

9 Regarding stressed syllables, see Halle and Lerdahl (1993).

10 Temperley (2001, 32–33).

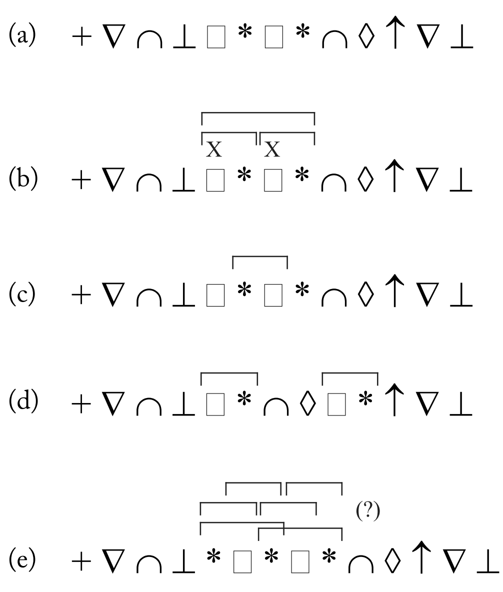
11 The relationship between harmony and meter is complex, as meter (once established) can also guide our intuitions about points of harmonic change (Temperley 2001, 150–51). In Ex. 3 we would probably hear the shift from V to I at note 8 rather than note 7 (even though note 7 would also be compatible with I).

One point that is not made by Lerdahl and Jackendoff is that meter can also affect grouping. Imagine a series of quarter notes, fading in, with a sforzando on every third note; these notes will tend to be heard as strong beats, which in turn will make them seem like the beginnings of groups. Thus, in addition to the strong-beat-early MPR, there should really be a strong-beat-early GPR: We prefer a grouping structure in which strong beats fall near the beginnings of groups.

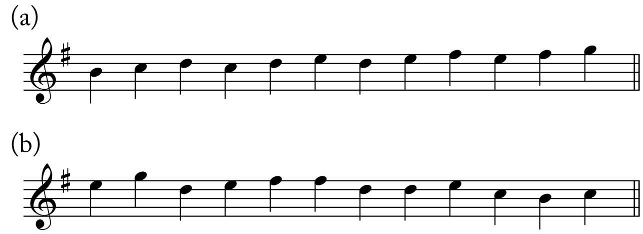
Lerdahl and Jackendoff include parallelism as a preference factor influencing both grouping structure and metrical structure. With regard to grouping, their GPR 6 states, "Where two or more segments of music can be construed as parallel, they preferably form parallel parts of groups";[12] their MPR 1 states, "Where two or more groups or parts of groups can be construed as parallel, they preferably receive parallel metrical structure."[13] In both cases, however, their discussion is very brief. We now turn to a deeper exploration of the rhythmic effects of parallelism.

PARALLELISM

The role of pattern repetition in music perception can be illustrated by a visual analogy; see Example 4. The symbols in Example 4(a) are all equally spaced, so proximity does not favor any particular grouping; each symbol is also quite different from the adjacent ones, so the similarity principle has little effect, at least at a very local level. However, one feature of the pattern *does* affect our grouping of the symbols: the repetition of the



EXAMPLE 4 (a)–4(e). *A visual example demonstrating the effect of repeated patterns on grouping*



EXAMPLE 5. *Two melodies used in Deutsch's (1980) study: (a) a structured sequence, containing a repeated intervallic pattern; (b) an unstructured sequence*

"square-star" sequence. In fact, this affects our perception in two ways. The fact that the squares and stars form a repeated pattern causes them to group together in pairs, as shown by the lower brackets in Example 4(b). This is due to the fact that we always search for efficient ways of encoding what we perceive. If we identify the square-star sequence as a unit—a *Gestalt*—labeling it in our minds in some way (e.g., as "X" as in Ex. 4[b]), we can then represent the four-symbol sequence as "XX," thus reducing the encoding of it, and the associated memory load, from four symbols to two. If we grouped the first star and second square together, as in Example 4(c), there would be no repeated pattern, and no efficient encoding would be possible. Once the two-symbol groups are formed, the Gestalt principle of similarity applies, causing the two Xs to group together; this leads to the higher-level grouping shown by the upper bracket in Example 4(b). Thus, immediate repetition of a sequence of elements leads naturally to two levels of grouping: one level capturing single iterations of the pattern and another level combining the iterations together. If there were only one iteration of the square-star sequence, neither level of grouping would be formed. If two iterations of the square-star pattern were separated, as in Example 4(d), we might infer a lower level of grouping (identifying the square-star pairs) but not a higher one (grouping the pairs together). If the first square in Example 4(a) were preceded by a star, as in Example 4(e), the low-level grouping would become ambiguous; there are now two equally efficient groupings, or perhaps three if overlapping groups are allowed, as shown in the figure.

People naturally notice repeated patterns, using them to predict elements in a sequence and to encode sequences more efficiently. Several experimental studies have demonstrated this in the visual domain, using sequences of letters, numbers, flashing lights, or abstract visual patterns.[14] With regard to music, a classic experiment by Diana Deutsch presented listeners (musicians) with structured sequences containing repeated intervallic patterns, like Example 5(a), as well as unstructured sequences, like Example 5(b), and had them write the sequences down. Structured sequences were reproduced more accurately,

12 Lerdahl and Jackendoff (1983, 51).
13 Lerdahl and Jackendoff (1983, 75).

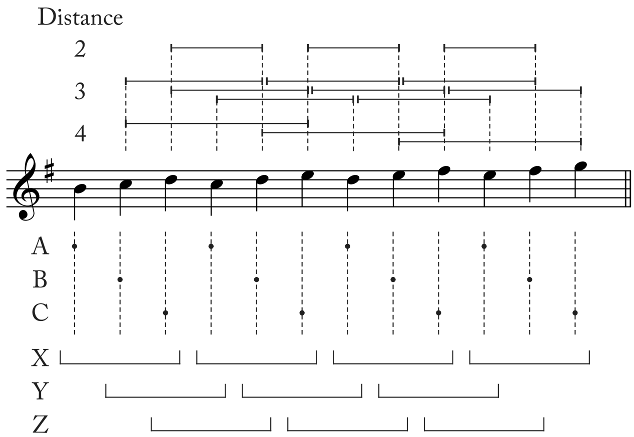
14 Bjork (1968) uses numbers; Kotovsky and Simon (1973) use letters; Vitz and Todd (1969) use abstract visual patterns; Restle and Brown (1970) use flashing lights.

indicating that listeners had noticed the repetitions and used them to encode the sequences.[15] This study shows that we are sensitive not only to exact repetitions of notes, but also to more abstract forms of repetition—in particular, patterns of diatonic intervals. Deutsch presents a symbolic system for encoding sequences, showing that a "structured" sequence (containing a repeated pattern) can be encoded more efficiently—with fewer symbols—than an unstructured one. Once a repeated pattern is identified, it need only be represented in memory once; an encoding of the melody can then indicate where the pattern occurs with "pointers" to its memory representation.

Following Lerdahl and Jackendoff, I will argue that parallelism has direct effects on both meter and grouping; we begin with meter.[16] Returning to Example 5(a), let us assume that the lowest level of beats has already been identified, so that every note coincides with a beat at that level; the task at hand is to identify the next level up. The listener will notice that certain diatonic intervals recur within the melody. Each descending step is followed by another descending step three notes later; the same is true of ascending steps (though ascending steps also repeat at other short distances such as two and four). If a note repeats the interval of an earlier note, we will say that the two notes form an "intervallically parallel pair." (We associate each note with the interval approaching it.) Example 6 reproduces Example 5(a) and shows all the intervallically parallel pairs at distances of two, three, and four; it can be seen that there are more of them at a distance of three than at distances of two or four.[17] We could say that a parallelism distance of three is prevalent or dominant in this passage. Perceptually, this suggests that there is a metrical level with a *period* (distance between beats in quarter notes) of three—that is to say, a dotted-half-note level. Importantly, the *phase* of the pattern (exactly where the beats fall) is undetermined by this process: the three beat levels shown in Example 6 (labeled A, B, and C) are equally preferable. I express this with the following MPR (which could take the place of Lerdahl and Jackendoff's MPR 1, mentioned above):

Parallelism MPR: Prefer metrical levels whose periods correspond to prominent parallelism distances in the passage.

I will call the system that identifies parallel note pairs the *parallelism finder*. The parallelism finder could also incorporate



EXAMPLE 6. *The melody in Example 5(a). Horizontal bars above the staff show intervallically parallel note pairs (pairs of notes approached by the same diatonic interval), at distances of 2, 3, and 4 notes. For example, the second and fifth notes are both approached by an ascending second, forming a pair at a distance of 3. Below the staff are shown three possible metrical levels (A, B, and C) and three possible groupings (X, Y, and Z)*

other kinds of repetition besides diatonic intervallic repetition, such as contour repetition, repetition of chromatic intervals, arpeggio patterns (patterns defined on the members of a chord), purely rhythmic repetition, or approximate or elaborated repetition. I will not explore these possibilities here.[18] No doubt some kinds of repetition are more salient and impactful than others; when not only the intervals but the *pitches* of a pattern are repeated, the pattern seems especially salient.

We can think of the parallelism finder as a module in a cognitive system of several interacting components; Example 7 shows how it serves as input to a meter module that generates metrical structure.[19] As noted above, however, the parallelism finder only influences the *periods* of metrical levels; what determines which phases of these levels are perceived? Usually, in actual music, phenomenal accents come into play to favor one phase over the others. If the first note in Example 6 were accompanied by a bass note, as in Example 8(a), beat level A would be favored; if the third note were emphasized in this way, as in Example 8(b), beat level C would be favored. (The last note of the melody could be said to carry a slight phenomenal accent, since its inter-onset interval is long, or at least understood to be long, but this is a fairly weak factor, to my mind.) In Example 8(b), one cannot really say that there is a phenomenal accent on the sixth eighth note; the feeling of accentuation there arises only from a kind of analogy with the

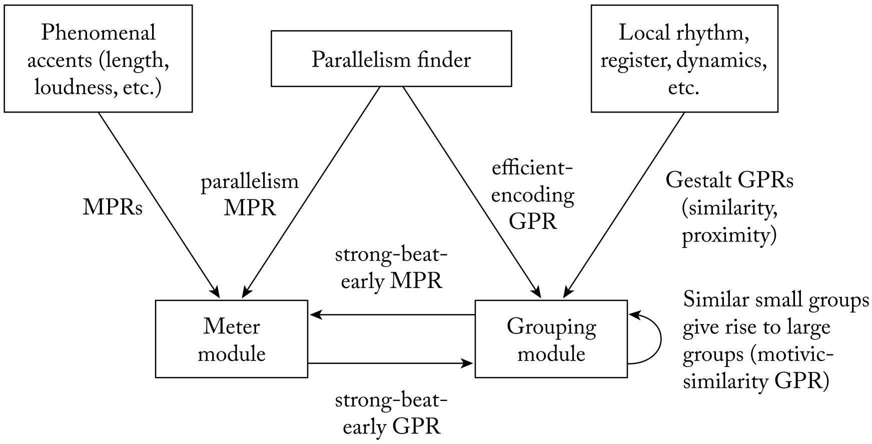
15 Deutsch (1980). A more recent study found that repeated intervallic patterns facilitate encoding for non-musicians as well (Zak, Temperley, and Pfordresher 2025).

16 My treatment of the direct effect of parallelism on meter closely follows a model proposed in Temperley and Bartlette (2002).

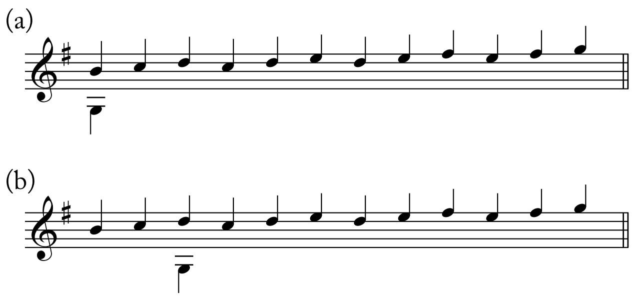
17 Why consider just two, three, or four? As Lerdahl and Jackendoff observe (1983, 69), there is an assumption (at least in common-practice music) that metrical levels will be either duple or triple: every second or third beat at one level will be a beat at the level above. A distance of four is possible with two duple levels; a distance of five would be strongly dispreferred; some longer distances would be possible as combinations of duple and triple levels.

18 See Temperley and Bartlette (2002) for further discussion.

19 I use the term "module" here to mean nothing more than one of several interacting components in a system; I do not assume that components are "modular" in the stricter sense proposed by Fodor (1983), e.g., as being informationally encapsulated from one another.



EXAMPLE 7. *A diagram of the model of rhythm perception proposed here*



EXAMPLE 8. *The melody in Example 6 with a bass note added: (a) to emphasize the first note; (b) to emphasize the third note*

third note. Coining a term, I will refer to such accents (accents due to parallelism) as "parallelic accents."[20]

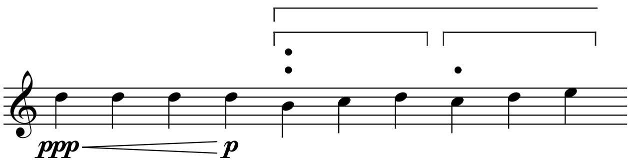
Parallelism also has a direct effect on grouping. Let us suppose that the representation above the staff in Example 6, created by the parallelism finder, serves as input to a grouping module. As noted earlier, when a passage features a repeated intervallic pattern, it is desirable to form groups that align with the repetitions, since that allows an efficient encoding. This favors three-note groups in the case of Example 6. It is not obvious, though, where exactly the groups begin and end; Example 6 shows three possible groupings below the staff (X, Y, and Z), each of which yields a repeated intervallic pattern. Here, too, encoding efficiency comes into play. Grouping X allows the entire sequence to be encoded as four iterations of a single three-note (or two-interval) pattern. By contrast, groupings Y and Z each only allow three iterations of a three-note pattern; three notes are left over and must be encoded separately. Thus, from the point of view of efficiency, grouping X is favored. This principle is captured in the following rule, which could take the place of Lerdahl and Jackendoff's GPR 6 (mentioned earlier):

> *Efficient Encoding GPR*: Prefer a grouping structure that allows an efficient encoding, minimizing the number of symbols needed to encode the passage.

In principle, this rule should be extendable to cases of approximate repetition or elaboration. For example, if some motive M is repeated but with an altered final interval, it might still be more efficient to encode it in this way—as "M with an altered final interval"—rather than encoding it as a completely different pattern.

Grouping decisions guided by parallelism might, in turn, influence meter. Recall that, in Example 6, the parallelism MPR favors a metrical level with a three-note period but is indifferent to its phase. Once grouping X is chosen (due to encoding efficiency), the first note in each group is favored as metrically strong, due to the strong-beat-early preference; this favors beat level A. I will call this the "early in motive" effect: we tend to hear the strongest beat in a repeated motive as occurring near the beginning of the motive. This does not need to be included as an independent rule; it emerges from the combined effect of the efficient-encoding GPR and the strong-beat-early MPR. In the case of Example 6, the early-in-motive effect is not really needed; the strong-beat-early rule will favor the first note as metrically strong simply because it is the beginning of a

20 One could perhaps consider parallelic accents as a type of phenomenal accent, but I prefer not to do so. Phenomenal accents are inherently local: some property of an event makes it accented in relation to nearby events. Even grouping accents are local in a loose sense since they arise from the presence of a nearby grouping boundary. By contrast, a parallelic accent is inherently *non*-local: it arises only from the fact that the event occupies the same position in a repeated pattern as a phenomenally accented event in another instance of the pattern. Parallelic accents also differ from metrical accents (accents that arise only from meter), which are non-local in another way: a metrical accent arises from a *time interval* between two accented points that is projected on to the current point. Imagine an isochronous pattern C D E C D E E E E E E …; if note 3 were marked by a phenomenal accent (e.g., a bass note), note 6 would carry a parallelic accent, and note 9 would carry a purely metrical accent.



example 9. *The repeated pattern affects grouping (at two levels) which in turn affects meter (at two levels)*

large group (the entire melody). The effect is more clearly illustrated by something like Example 9 (imagine it fading in from silence). In this case, it is only parallelism (efficient encoding) that gives rise to the grouping shown; this in turn makes the B seem metrically strong.

We have seen that the effect of parallelism on grouping arises naturally from the desire for encoding efficiency, and that grouping affects meter. In that case, one might wonder if the effect of parallelism on meter is simply an indirect effect, mediated by grouping; do we really need to say that parallelism affects meter directly? I believe we do. The effect of grouping on meter is quite weak, especially at small time scales. Consider Example 10(a); the grouping of the right hand is clear (shown with brackets above the staff), but there is little tendency to hear a half-note metrical level aligned with it.[21] Compare this to my recomposition of the passage in Example 10(b), in which the groups contain a repeated melodic motive; now, the tendency to hear a half-note metrical level (or at least, a pattern of accents in conflict with the $\frac{3}{4}$ meter) is much stronger. This cannot be explained as an effect of grouping structure on meter; the grouping structure is the same in both cases. Rather, it reflects the direct effect of parallelism on meter. Again, though, this direct effect only relates to the periods of metrical levels, not their phases.[22]

Besides favoring the formation of groups aligned with repeated patterns, parallelism has a further effect. I noted with regard to Example 4 that, once consecutive instances of a pattern have been identified, we tend to group them together. This is simply the application of the principle of grouping by similarity—already recognized by Lerdahl and Jackendoff at the level of notes—at the higher level of motives. I express it as follows:

> *Motivic Similarity GPR*: Prefer to combine adjacent groups containing repetitions of a motive into a larger group.

Once again, this rule has an effect on meter. Due to the strong-beat-early preference, grouping motivic repetitions into a larger group will favor a strong beat near the beginning of the larger group, somewhere within the first occurrence of the pattern. Example 9 illustrates this point. Efficient encoding gives rise to three-note groups, which favors dotted-half-note beats at the points shown; a larger group is then created to subsume the small ones, and this in turn causes the first accented note to be heard as metrically stronger than the second. In general, the combination of efficient encoding and the strong-beat-early preference means that the strongest beat in a series of immediate repetitions of a pattern tends to fall within the first occurrence of the pattern; I will call this the "first occurrence strong" effect.[23] Again, this effect arises naturally from other preferences: the strong-beat-early MPR and the motivic-similarity GPR.

The most stable situation is one in which the boundaries of repeated patterns are reinforced by other cues to grouping, such as rests. Common-practice composers generally facilitate the segmentation process by aligning these cues, often yielding clear, symmetrical grouping structures at multiple levels. Even when a large group splits into two smaller ones that are quite dissimilar, they are usually at least similar in length, which may in itself facilitate encoding. Example 11 is illustrative—though also, in a way, exceptional. Two four-measure, end-accented phrases arise (marked by the upper brackets) due to efficient encoding and other factors; they naturally combine into a larger eight-measure group, supported by rests at both ends. However, the four-measure phrases do not divide evenly; a repeated half-measure motive suggests a one-measure group within each phrase (marked by the lower brackets—this is the motivic-similarity GPR operating at a lower level), overlapping the midpoints of the phrases (shown with dotted lines). This creates a rather unusual rhythmic effect.

Example 7 summarizes the complex interactions described here. The process begins with the parallelism finder, which identifies pairs of low-level beats that are parallel in interval or in some other way; it outputs something like the top part of Example 6. (We must assume that a low metrical level has already been established, defining the beats to be compared.) This output is direct input to the meter module, which favors metrical levels whose periods are supported by parallel note pairs. Phenomenal accents also provide input to the meter module. The parallelism finder also serves as direct input to the grouping module, which looks for an efficient encoding in which parallel events fall at the same place within groups. Other preferences (similarity and proximity) also affect grouping. Low-level grouping affects high-level grouping, favoring the grouping together of consecutive iterations of a pattern. Grouping and meter may interact, due to the preference for

21 Albéniz's original has a phrasing slur over the first measure in the right hand. This suggests groups that align with the bar lines, in contrast to the three-note groupings shown in Ex. 10(a); in turn, this reinforces the notated meter (due to the strong-beat-early preference) and makes the hearing of a half-note metrical level even less likely.

22 Just like with meter and grouping, or meter and harmony (see note 11), the influence between meter and parallelism goes both ways: once meter is established, it influences the pattern repetitions that we perceive (Acevedo, Temperley, and Pfordresher 2014).

23 In earlier work (Temperley 2001, 50–51), I incorporated this preference as a "first occurrence strong" MPR; Rothstein (2011, 96) notes an earlier expression of this idea in Tetzel (1921).

EXAMPLE 10. *(a) Albéniz, "Seguidillas" from* Chants d'Espagne*, mm. 102–3; (b) A recomposition of Example 10(a)*

EXAMPLE 11. *Schubert, String Quintet in C Major, D. 956, first movement, mm. 138–46*

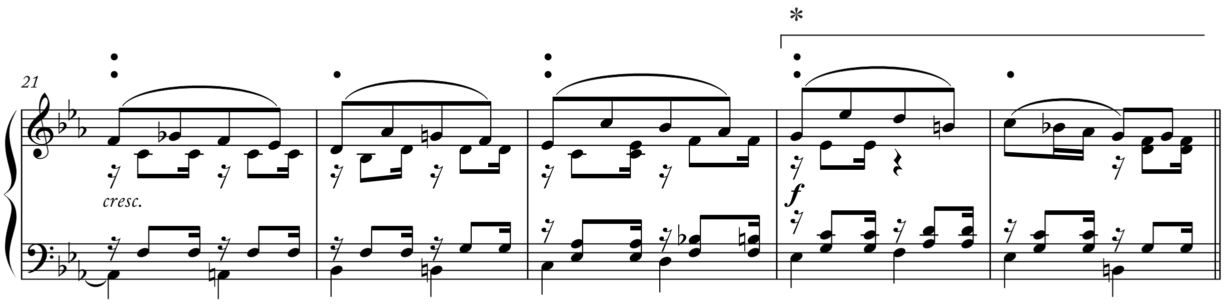
strong beats to be placed early in groups; either one may influence the other. Parallelism can also affect the phase of metrical levels indirectly through grouping, by favoring strong beats near the beginning of a repeated motive or in the first occurrence of a repeated motive.

Parallelism also has a more large-scale effect: when a motive or theme comes back later in a piece, we prefer to interpret it the same way as we did originally, with regard to both meter and grouping. In Example 12, the measure marked with a star occurs in the middle of a sequence and seems hypermetrically weak in its immediate context; but when it occurs, we recognize it as the return of the beginning of the piece, which makes it the beginning of a large group (a section boundary), in turn marking it as hypermetrically strong. This "long-distance" effect of parallelism seems more affected by exact repetitions as opposed to weaker forms such as intervallic or contour repetition.[24]

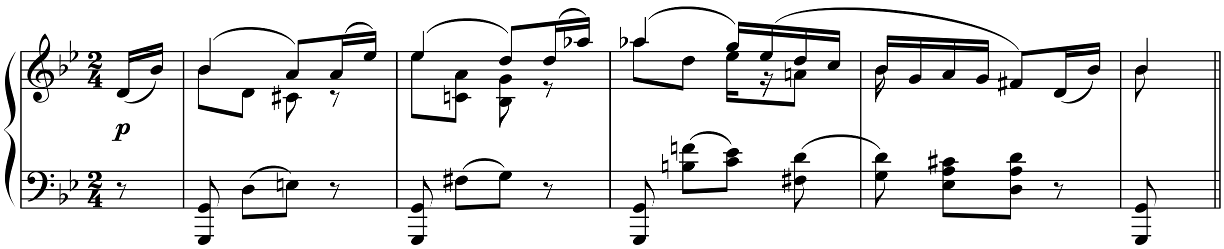
SOME EXAMPLES

In many cases, the factors involved in grouping and meter perception point more or less unanimously to a single rhythmic (metrical and grouping) analysis. Example 13 is illustrative.

24 Listeners are most sensitive to repeated intervallic patterns at short distances; at longer distances, exact repetition of pitch or scale-degree patterns takes priority (Dowling and Bartlette 1981). Compositional practice reflects this as well; repeated intervallic patterns become less common at longer distances, compared to repeated pitch patterns (Temperley 2024).

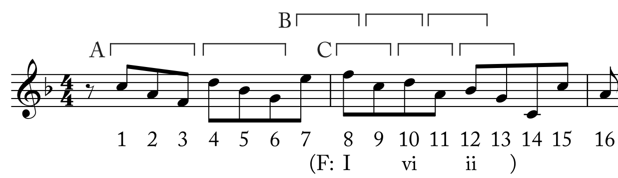


example 12. *Mendelssohn,* Song without Words, *Op. 38, No. 2, mm. 21–25*



example 13. *Clara Schumann, Piano Sonata in G Minor, fourth movement, mm. 1–5*

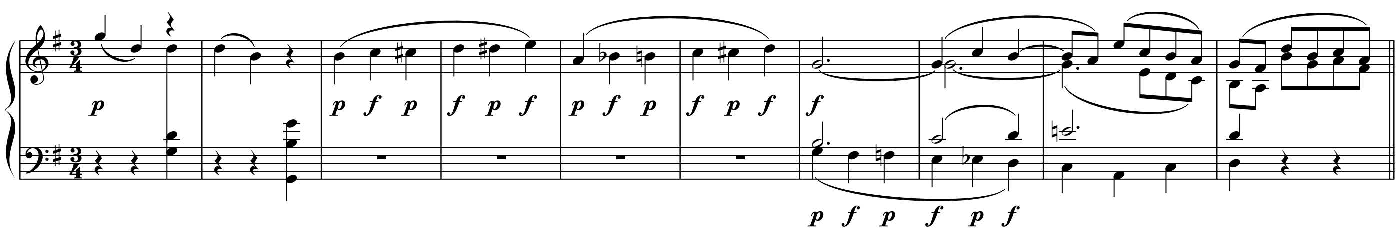
Considering just the melody, the greater length of the quarter notes favors strong beats at those locations, suggesting a half-note level. This is further supported by the fact that the beginning of a piece is always a high-level group boundary, favoring the first quarter-note beat as stronger than the second due to the strong-beat-early preference. With regard to low-level grouping, the proximity factor suggests boundaries after the quarter notes, but the slurs ending on the second notes of mm. 1 and 2 imply slight articulative breaks after those notes, which also suggest boundaries. The effect of meter on grouping favors the latter analysis, since this places the strong quarter-note beats (the first and third) nearer the beginning of the groups. Thus, the rhythmic structure of the passage is fairly clear, even without parallelism, but parallelism affirms it. The first four notes of the melody form a rhythmic and diatonic intervallic pattern, repeated in the next four notes (though the first interval is changed from a sixth to a fifth). Grouping the notes in this way allows an efficient encoding; placing boundaries after the quarter notes—creating a three-note group followed by a four-note group—would be less efficient. The repeated rhythmic and intervallic pattern also favors a metrical level with a period of one half-note, supporting the level implied by the phenomenal accents. At a higher level, the repeated pattern favors grouping the two four-note groups into a larger one, and this in turn affects higher-level meter, making the first downbeat seem stronger than the second. Features of the accompaniment—the phenomenal accents created by the left-hand octaves, the grouping boundaries implied by the rests, and the repeated intervallic/rhythmic pattern—add further confirmation to the rhythmic analysis implied by the melody. The harmony



example 14. *Handel,* Water Music *Suite No. 1 in F Major, first movement, mm. 13–15*

generally supports this analysis too, with chord changes on quarter-note beats, though the anticipations at the end of mm. 1, 2, and 4—belonging to the following harmony rather than the current one—create subtle syncopations.

The effects of parallelism are more apparent when other factors influencing meter and grouping are relatively neutral. In Example 14, the repeated three-note intervallic motive in m. 1 suggests grouping A (encoding efficiency); metrical parallelism also favors a dotted-quarter level here, and the strong-beat-early preference favors a beginning-accented pattern, with the first and fourth notes as strong. But the repeated intervallic pattern in notes 7 through 12 clearly implies a quarter-note metrical level, forcing a metrical shift. What about its phase: Which notes are stronger, odd-numbered (7, 9, and 11) or even-numbered (8, 10, and 12)? The strong-beat-early preference may play a role here, but the grouping structure is ambiguous; two possible analyses are shown, roughly equal in encoding efficiency. (Grouping C is the weaker of the two, as the third instance of the pattern features a third rather than a



EXAMPLE 15. *Mozart, String Quartet in G Major, K. 387, fourth movement, mm. 1–10*

fourth.) Each grouping favors a phase of the quarter-note level, but this has only a weak effect; one can certainly hear grouping B in an end-accented fashion, combined with the notated quarter-note level. The decisive factor here is harmony: treating notes 8, 10, and 12 as strong allows a harmonic analysis (shown below the staff) in which chord changes occur on quarter-note beats and all notes are chord tones.

As noted earlier, the effect of parallelism on metrical phase is indirect, through the influence of grouping and the strong-beat-early preference. It can happen in two ways: via the preference for a strong beat on the first occurrence of a motive (the first-occurrence-strong effect) or via the preference for strong beats early in a repeated motive (the early-in-motive effect). And now—at last! —we can address the Bach Allemande discussed at the beginning of the essay (Ex. 1). As noted there, our perception of the downbeat shifts from notated beat 1 (in mm. 1–3) to notated beat 3 (in mm. 3–10). In the Baroque period, a $\frac{4}{4}$ time signature was often interpreted to imply two equal $\frac{2}{4}$ measures.[25] In such cases, there may be no sense of a higher "whole-note" level, or it may come and go, either in phase or out of phase with the notated bar lines (we could call these "odd-strong" and "even-strong" interpretations, respectively, referring to odd-numbered or even-numbered half-note beats). In the Allemande, the repeated intervallic pattern in the first five half-measures (though slightly different on each occurrence) establishes the half-note level, and the first-occurrence-strong effect favors an odd-strong hearing. However, when a new pattern is introduced in the second half of m. 3 and repeated in the following half-measure, the first-occurrence-strong effect favors that half-measure as strong, shifting us to an even-strong hearing.[26] The even-strong hearing is reinforced later in the passage, but in a different way: a new pattern begins in the second half of m. 6 that is one whole note in length, causing grouping boundaries aligned with the pattern, and the early-in-motive effect then favors strong beats on the first half of each instance of the pattern.

The effects of parallelism on metrical phase can sometimes be observed at the very beginning of a piece. When the second and third metrical segments of a piece feature a repeated pattern (we could call this an "ABB" scenario), the first-occurrence-strong effect favors the second metrical segment as strong, conflicting with the general preference for an "odd-strong" hearing. Example 15 shows a case in point. At the two-measure level, odd measures are clearly stronger than even ones, but what about the four-measure level—which of the odd-numbered measures are strongest? Here, too, we would normally favor an odd-strong hearing, favoring the first and third two-measure beats (mm. 1 and 5) over the second and fourth (mm. 3 and 7). However, the fact that the pattern in mm. 3–4 repeats in mm. 5–6 creates an ABB situation (where each segment is two measures), making m. 3 feel stronger than m. 5. A complete four-measure hypermeasure follows in mm. 7–10, creating a ten-measure phrase; this suggests that the composer heard the hypermeter in this way as well.

Another opening by Mozart, shown in Example 16, illustrates the early-in-motive effect at the beginning of a piece. The harmonic progression of the first four measures, I–V–V–I, is quite conventional, often used in conjunction with melodic patterns such as $\hat{1}$–$\hat{7}$–$\hat{4}$–$\hat{3}$, $\hat{3}$–$\hat{2}$–$\hat{4}$–$\hat{3}$, or (as in this case) $\hat{1}$–$\hat{7}$–$\hat{2}$–$\hat{1}$.[27] Frequently, it involves an ABAB motivic pattern; in that case, AB emerges as a repeated motive, and the early-in-motive effect favors the A segments as strong, supporting the odd-strong hearing that is normally favored at piece beginnings. In Example 16, however, m. 3 is motivically more similar to m. 5 than to m. 1; we could call this an ABCBC pattern. Thus, the repetition that leaps to the ear is between the BC segments—between mm. 2–3 and mm. 4–5; the early-in-motive effect then favors mm. 2 and 4 as strong. The long notes and pre-dominant harmony starting on the downbeat of m. 6 and extending into m. 7 also support this hearing. On the other hand, the general preference for odd-strong remains, and the repeat of the large phrase starting in m. 9 supports an odd-strong hearing as well. To my mind, then, the hypermeter is somewhat ambiguous.

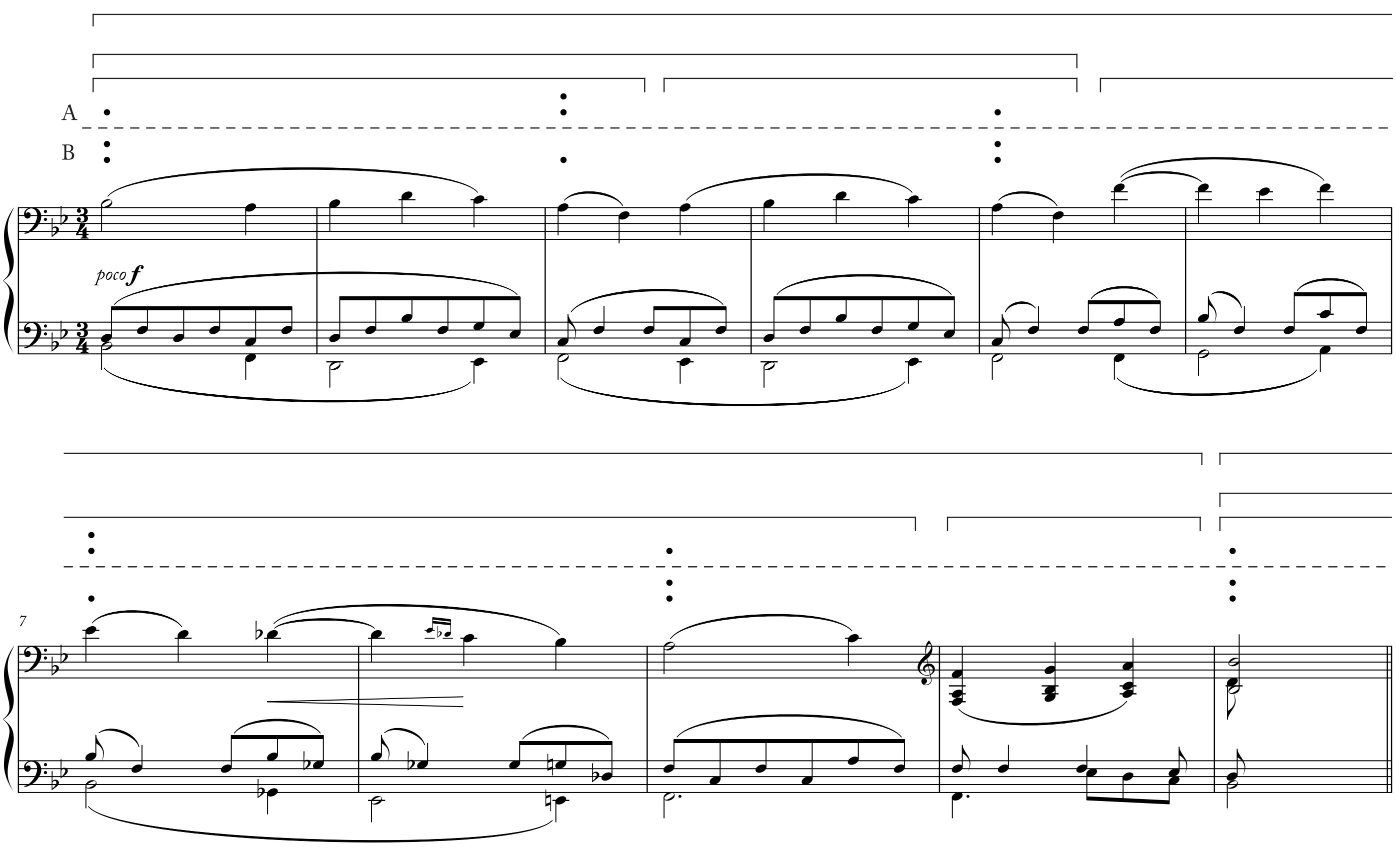
Example 17 presents a more complex situation, the beginning of Brahms's Sextet, Op. 18. The opening phrase repeats, starting in m. 11, in a different textural arrangement; this establishes the first ten measures as a large group (though one could

25 Grave (1985).

26 The pedal B♭ that begins on the second half of m. 3 may have an effect here as well. This shows that the effect of harmony on meter is sensitive to the *hierarchical* nature of harmonic structure: a "structural" harmonic change may carry more weight than a more superficial one. However, the shift in meter seems clear even if the pedal is removed.

27 These are common harmonic-melodic schemata, as observed by Gjerdingen (2007, 469).

EXAMPLE 16. *Mozart, Serenade in D Major, K. 320, fourth movement, mm. 1–9*



EXAMPLE 17. *Brahms, String Sextet in B♭ Major, Op. 18, first movement, mm. 1–11*

say it overlaps with the following phrase at the downbeat of m. 11). The melodic parallelism between mm. 2–3 and mm. 4–5 creates an ABCBC pattern, favoring grouping boundaries that coincide with the repetition. The early-in-motive effect might then encourage hearing mm. 2 and 4 as strong. However, m. 1 also seems to group with m. 2, in light of the continued tonic harmony and the phrasing slur in the melody. One might then hear mm. 1–3 as an expanded version of mm. 4–5.[28] The parallelism between mm. 1–3 and 4–5 then causes the five measures to combine into a larger group, but now the beginning of the group is an odd measure (m. 1), favoring an odd-strong hearing (also favored by the fact that m. 1 is the beginning of the piece). Moving on, we find a weak suggestion of a repeated melodic motive in mm. 5–7 (F–E♭, then E♭–D), followed by a half-cadential gesture in mm. 8–9; this suggests the possibility of hearing mm. 1–9 as a sentence—a pattern of 2 + 2 + 4 measures, expanded in this case to 3 + 2 + 4.[29] Overall, I find an odd-strong hearing preferable for the entire phrase. It is especially hard for me to hear the end of the phrase as even-strong, due to the harmony: mm. 9 and 11 both initiate two-measure harmonic spans. (Measure 11 is an actual *change* of harmony, whereas m. 1 arguably is not.)

If we assume an odd-strong hearing, it is also of interest to consider the relative strength of odd-numbered measures. If m. 4 is weak (relative to m. 5), that makes mm. 1–2 (an expansion of m. 4) seem weak in relation to m. 3. Presumably, m. 1—as the beginning of a two-measure expansion—is stronger than m. 2, but it is weak at the two-measure level (meaning that m. 3 has a beat at the four-measure level and m. 1 does not).[30] This is shown as analysis A (only the two-measure and four-measure levels are shown). By this hearing, mm. 1–3 are a kind of *metrical* expansion of mm. 4–5—shifting the "weak-strong" structure of the segment to a higher metrical level. Continuing the four-measure level from m. 3 makes m. 5 weak at the two-measure level, and the first-occurrence-strong effect (given the parallelism between mm. 1–3 and 4–5) supports this as well. On the other hand, the larger phrase still favors m. 1 (and m. 5, if a four-measure level is assumed) as stronger than m. 3; this is shown as analysis B. Either analysis of the four-measure level will require a shift when the large phrase repeats; a four-measure hypermetrical level cannot be continued through two iterations of a ten-measure phrase, if the large-scale parallelism between the phrases is respected. Yet another option (not shown) is to hear both mm. 1 and 11 as strong but shift to an even-strong hearing of mm. 2–9; this brings out the conventional eight-measure sentence structure and allows the typical hypermetrical hearing for such a structure. These hypermetrical ambiguities and possibilities give rise to a rich and complex rhythmic experience.

PARALLELISM, METRICAL DISSONANCE, AND SYNCOPATION

So far, we have focused on how pattern repetition affects the perception of meter at the beginning of a piece or causes a shift in meter. Parallelism also has more subtle effects on our rhythmic experience, even when it does not actually affect the meter.

One such effect relates to metrical dissonance, an important rhythmic phenomenon explored by Harald Krebs.[31] Krebs addresses the situation where a musical passage presents "pulse layers" that are in conflict. Metrical dissonance takes two forms. In *grouping dissonance*, two pulse layers have different periods; in Example 18(a), the long notes in the violin in mm. 33–34 and the repeated pattern in the piano suggest a half-note level conflicting with the previously established dotted-half-note level. In *displacement dissonance*, the two conflicting layers share the same period but differ in phase; in Example 18(b), the pulse layer formed by the accented second beats (due to the long notes and long harmonic spans initiated on those beats) has a period of one dotted-half-note, like the notated measure, but is displaced from it by one beat. Generally, Krebs describes one of the two conflicting layers as "metrical" and the other as "antimetrical." There is some ambivalence in Krebs's writing as to whether an antimetrical layer is part of the meter, or simply a pattern of accents in conflict with the meter.[32] I favor the latter view, partly because it is generally difficult if not impossible to

28 See Rothstein (1989, 64–101) for discussion of phrase expansion. This is an unusual case where the expansion of a segment seems to precede the underlying version of the segment, rather than following it.

29 See Caplin (1998, 9–12) on sentences. In a sentence, the four-measure phrase is often divided into 1+1+2, which is suggested (again, weakly) in this case.

30 One could say, since m. 2 is literally the same as m. 4 melodically, the strongest parallelism is between these two measures, but this reading also makes m. 2 weak—since m. 4 is also weak—though it leaves undetermined the status of m. 1.

31 Krebs (1999).

32 Krebs's graphic representations of metrical dissonances look very much like metrical grids (though with coffee beans rather than dots), with two layers conflicting either in period or in phase (e.g., Krebs 1999, 32 and 34), and Krebs acknowledges this similarity (260). This suggests that he regards metrical dissonance as a metrical phenomenon: pulses are *beats*, in Lerdahl and Jackendoff's terms—subjectively accented points of time in the listener's mind—and a metrical dissonance involves conflicting levels of beats. However, the fact that he labels one layer within a metrical dissonance as "metrical" and the other as "antimetrical" suggests that the latter one is *not* truly part of the meter. And at one point (22), he seems to endorse a view of metrical dissonance as a kind of *syncopation*, which normally suggests a pattern of accents in conflict with the meter. Subsequent studies that have engaged with both *GTTM* and Krebs's theory, notably Mirka (2009) and Santa (2020), reflect this ambivalence as well: they represent metrical dissonances with grids (layers of beats), but at the same time treat one level of the dissonance as antimetrical or conflicting with the underlying meter—in Mirka's words, the notated meter normally remains the "frame of reference" (168). Yet a third possibility is that the antimetrical layer could simply become the meter, supplanting the metrical level; both Mirka (168) and Santa (63–64) suggest that this can occur if the dissonance is prolonged and "indirect" (that is, if the metrical level is not articulated). I would rather treat such cases simply as metrical *shifts*, rather than dissonances. All this requires more discussion than I can offer here.

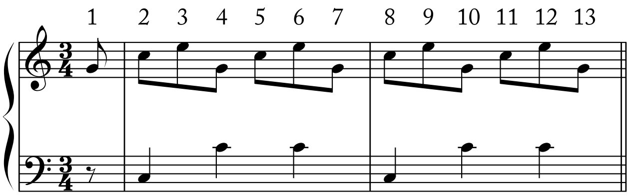
example 18. *(a) Brahms, Violin Sonata in A Major, Op. 100, first movement, mm. 31–34; (b) Brahms, Violin Sonata in A Major, Op. 100, first movement, mm. 79–82; (c) A rebarring of Brahms, Violin Sonata in A Major, Op. 100, first movement, mm. 79–82*

maintain two metrical structures at once.[33] In Example 18(b), try to hear the meter aligned with the second-beat accents, as notated in Example 18(c). With effort, I can force myself to do this. But now, try hearing it in both ways at once, combining the two meters; I find this completely impossible. (In the case of grouping dissonance, feeling two conflicting pulse layers as metrical seems somewhat more plausible—an interesting issue that I will not pursue further here; for consistency, I will describe both grouping dissonance and displacement dissonance as cases where patterns of accents conflict with the meter.)

How does parallelism relate to metrical dissonance? Recall that the direct effect of parallelism on meter is to imply a metrical level of a certain period. With displacement dissonance, the two conflicting pulse layers have the same period, so parallelism expresses no preference between them. With grouping dissonance, however, the two layers differ in period, and parallelism is often a factor.[34] Consider Example 19; the repeating

33 A number of experimental studies of the perception of polyrhythms point to this conclusion. See London (2012, 67) for an excellent summary.

34 The effect of parallelism on grouping dissonance is explored at length by Mirka; she finds discussions of this effect even in the writings of eighteenth-century theorists (2009, 133–36).



EXAMPLE 19. *Grouping dissonance arising purely from parallelism*

pattern in the right hand creates an accent pattern that conflicts with the $\frac{3}{4}$ meter implied by the left hand. Let us suppose that the left-hand line determines the primary meter and that the right-hand line is heard as creating a grouping dissonance—a pulse layer with pulses at notes 2, 5, 8, and 11; what creates the sense of antimetrical pulses at positions 5 and 11? There is no phenomenal accent at these positions; the accents are entirely parallelic.[35]

Another way that parallelism can create accentual conflicts with meter is through its influence on grouping. Consider Example 20: This eight-measure phrase (like most eight-measure phrases) creates a clear sense of duple hypermeter, with odd-numbered measures stronger than even-numbered ones; one could also posit a four-measure metrical level with beats at mm. 1 and 5. However, the melodic motive introduced in m. 4 and repeated in mm. 5 and 6 creates a subtle conflict. This is because the motivic repetition causes mm. 4, 5, and 6 to group together (the motivic-similarity GPR); this in turn creates a grouping accent at the downbeat of m. 4. This exerts slight pressure on our metrical perception of the theme (due to the first-occurrence-strong effect), but not enough to override the regular hypermeter; it just adds a touch of instability and charm. A single accent in conflict with the meter—as we have here—is best described simply as a syncopation, rather than a metrical dissonance; the latter refers to a regular *pattern* of conflicting accents.

Example 21(a) is another instance of a conflict between parallelism and meter, mediated by grouping. The change of texture and change of harmony (from an implied V to I) on the downbeat of m. 2 clearly marks that as a strong beat, and the notated meter seems fairly clear from then on (though with subtle elements of conflict, such as the move to V^7—over a tonic pedal—on the second beat of m. 2 continuing over the bar line); an even-strong hypermeter can also be heard. Notice, however, the one-measure motive beginning on the second beat of m. 5, presented three times (marked with brackets—though the second and third instances are slightly modified). This suggests grouping boundaries aligned with the motive—in conflict with the grouping suggested by the phrasing slurs—which in turn gives a slight accent to the second beats of mm. 5, 6, and 7 (the early-in-motive effect). This could be considered a displacement dissonance: a pattern of accents out of phase with the meter. While the one-measure groups shown in Example 21(a) may seem fairly weak—outweighed by the phrasing slurs—consider also Example 21(b), a passage occurring later in the same section. In this case the phrasing slurs align with the repeated motive; this in turn strengthens the grouping accents on the second beats (of mm. 21–23) and heightens the conflict with the meter. Harmonically, too, the previous phrase now seems to end on a downbeat (of m. 21) rather than on the second beat (as in m. 5), further supporting a group beginning on the second beat of m. 21, in alignment with the motive. In retrospect, the second-beat accents in mm. 21–23 give subtle support to the parallel analysis of mm. 5–8.

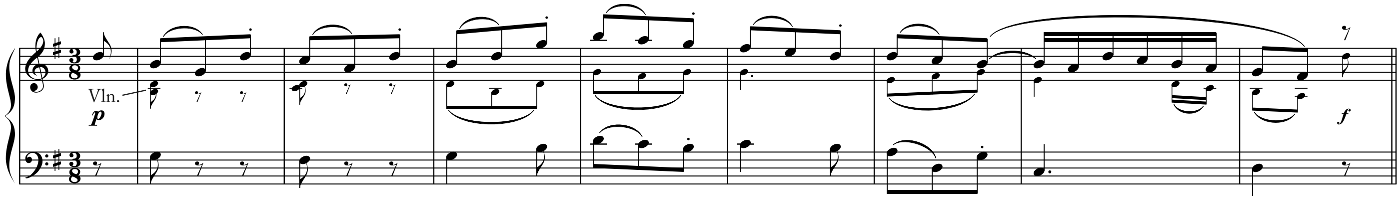
PARALLELISM AND METRICAL IRREGULARITY

Stepping outside the main topic of this essay, I wish to briefly consider the role of parallelism in twentieth-century art music. I have in mind, in particular, a rhythmic idiom that is found in the music of some early twentieth-century composers, most famously Stravinsky. In this idiom, a low level of meter seems clear and regular (usually it is notated as the quarter-note or eighth-note level), but higher metrical levels are irregular.

Example 22 shows a case in point. (This is a bassoon line; horn and trombone double segments of the melody, and percussion marks each quarter-note beat.) The bar lines are not those in Stravinsky's score; rather, they represent a metrical analysis by Gretchen Horlacher, which I entirely endorse.[36] What I wish to emphasize about the passage is the crucial role of parallelism. The passage is saturated with repeated patterns—not just patterns of interval, but of pitch as well. As we listen to it, our parallelism finder is hard at work, detecting repetitions of pitch and interval at different distances—and it is largely the irregularity in these distances that creates the effect of metrical irregularity. The first part of the passage (up to m. 9) clearly establishes a half-note level, with long notes mostly falling on beats at that level. (Long notes in mm. 3 and 8 are clearly syncopations; the percussion establishes the quarter-note level beyond any doubt.) The motive A–G–F♯–E–A in mm. 2–3 and 7–8 is aligned with this half-note level in a consistent way, reinforcing it. The repetition of the motive in mm. 9–10 introduces some uncertainty, since the G is now on a strong

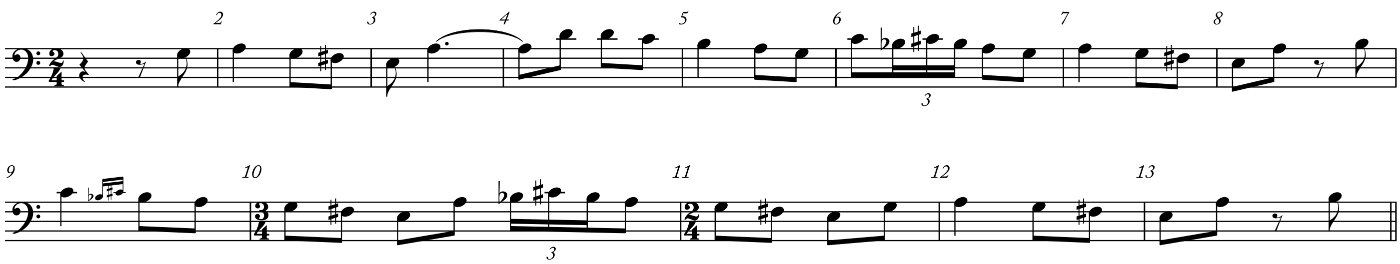
35 One problem in reconciling Krebs's theory with Lerdahl and Jackendoff's is the unfortunate term "grouping dissonance." This suggests that this type of dissonance is somehow related to grouping structure. In fact, grouping structure often plays little or no role in grouping dissonance (or in displacement dissonance, for that matter); phenomenal accents and parallelism play much greater roles. (This point was made earlier with regard to Ex. 10.) The grouping dissonance in Ex. 19 does not involve grouping structure: the grouping structure of the right hand surely aligns with the repeated motive, but the accents are felt in the middle of the motive, not at the beginning. While this problem is purely terminological, it could certainly cause confusion for students. (Perhaps a better term for grouping dissonance could be found, though I cannot think of one.) Grouping structure does sometimes play a role in creating accentual conflicts with meter, though, as I will discuss next.

36 See Horlacher (1995).



EXAMPLE 20. *Mozart, Violin Sonata in G Major, K. 301, second movement, mm. 1–8*

EXAMPLE 21. *(a) Chopin, Ballade No. 2 in F Major, mm. 1–9; (b) Chopin, Ballade No. 2 in F Major, mm. 20–25*



EXAMPLE 22. *Stravinsky, "Marche" from* Renard, *mm. 1–11 of the original (melody only), as rebarred by Horlacher (1995)*

quarter-note beat rather than a weak one, but arguably not enough to upset the $\frac{2}{4}$ meter; we simply hear the motive shifting in relation to it.[37] However, the A–G–F♯–E pattern then repeats just three beats later, strongly suggesting a momentary triple meter. This in turn is disrupted two beats later (m. 12) by the quarter-note A and the return of the complete A–G–F♯–E–A motive, in which the first A was previously understood as metrically strong. The accent on the G in m. 11 is purely parallelic, arising from its motivic connection to the G on the downbeat of m. 10. The accent on the A in m. 12 is partly phenomenal (due to the length of the note) but also parallelic—supported by long-distance parallelism—since we are accustomed to hearing the A of the motive on a strong beat.

It is significant that the parallelisms in Example 22 employ *exact* repetition (both pitch and intervallic), as opposed to the purely intervallic repetition that so often occurs in common-practice music (as in many of the examples earlier in this essay). This is characteristic of Stravinsky's rhythmic idiom. Exact repetition is especially salient, as observed earlier, and can seize

37 Note also the occurrence of the motive, or part of it, transposed up by a third in mm. 8–9. One could hear the seven notes B–C–B♭–A–G–F♯–E–A as an expanded version of the motive, possibly implying a $\frac{3}{4}$ measure starting on the C, but I find that less plausible.

our attention even when it contradicts the previously established meter. In passages such as this, Stravinsky is exploiting our sensitivity to parallelism to create a rapidly changing, highly irregular metrical experience.[38]

CONCLUSIONS AND FURTHER ISSUES

In this essay I have proposed an account of parallelism and its effects on meter and grouping. While I have not offered an actual computational implementation, my account takes significant steps in that direction by characterizing the effects of parallelism more precisely than Lerdahl and Jackendoff did in *GTTM*. I have argued that the effects of parallelism arise, in large part, out of a fundamental perceptual process—the search for efficient encodings—and I have tried to show that, interacting with other factors, parallelism adds greatly to the rhythmic interest and richness of common-practice music.

To what extent is the theory presented here—Lerdahl and Jackendoff's rhythmic theory with my augmented parallelism component—relevant to other musical styles? Certainly it is relevant to modern popular music, a topic I have avoided for reasons of space but hope to explore elsewhere. I have argued that it has at least some applicability to twentieth-century art music as well. One might wonder if it can also be applied to non-Western musical styles. Some of the preference rules discussed here emerge naturally from more general principles of perception and cognition, notably Gestalt principles of similarity and proximity. Some phenomenal accent rules are similar in this regard, since they seem to be general mechanisms of drawing attention to points in time: loudness and syllabic stress, for example. The idea that listeners search for an efficient encoding of a piece—really the central idea of the account proposed here—also arises out of a general cognitive principle and seems likely to have broad applicability to music. However, the specific ways that meter, grouping, and pattern repetition interact may turn out to vary considerably across styles. Exploring these interactions in other musical idioms would seem to be a natural area for further study.

WORKS CITED

Acevedo, Stefanie, David Temperley, and Peter Q. Pfordresher. 2014. "Effects of Metrical Encoding on Melody Recognition." *Music Perception* 31 (4): 372–86.

Benjamin, William E. 1984. "A Theory of Musical Meter." *Music Perception* 1 (4): 355–413.

Bjork, Robert A. 1968. "All-or-None Subprocesses in the Learning of Complex Sequences." *Journal of Mathematical Psychology* 5 (1): 182–95.

38 Sullivan (2021) finds similar effects in the works of Schoenberg, Barber, and several other twentieth-century composers.

Caplin, William. 1998. *Classical Form: A Theory of Formal Functions for the Instrumental Music of Haydn, Mozart, and Beethoven*. New York: Oxford University Press.

Deliege, Irene. 1987. "Grouping Conditions in Listening to Music: An Approach to Lerdahl & Jackendoff's Grouping Preference Rules." *Music Perception* 4 (4): 325–59.

Deutsch, Diana. 1980. "The Processing of Structured and Unstructured Tonal Sequences." *Perception & Psychophysics* 28 (5): 381–89.

Dowling, Walter, and James Barlett. 1981. "The Importance of Interval Information in Long-Term Memory for Melodies." *Psychomusicology* 1: 30–49.

Fodor, Jerry A. 1983. *The Modularity of Mind*. Cambridge, MA: MIT Press.

Gjerdingen, Robert O. 2007. *Music in the Galant Style*. New York: Oxford University Press.

Grave, Floyd K. 1985. "Metrical Displacement and the Compound Measure in Eighteenth-Century Theory and Practice." *Theoria* 1: 25–60.

Halle, John, and Fred Lerdahl. 1993. "A Generative Textsetting Model." *Current Musicology* 55 (3): 3–23.

Hasty, Christopher. 1997. *Meter as Rhythm*. New York: Oxford University Press.

Hayes, Bruce. 1995. *Metrical Stress Theory: Principles and Case Studies*. Chicago: University of Chicago Press.

Horlacher, Gretchen. 1995. "Metric Irregularity in 'Les noces': The Problem of Periodicity." *Journal of Music Theory* 39 (2): 285–309.

Ito, John Paul. 2021. *Focal Impulse Theory: Musical Expression, Meter, and the Body*. Bloomington: Indiana University Press.

Jackendoff, Ray. 1991. "Musical Parsing and Musical Affect." *Music Perception* 9 (2): 199–229.

Klorman, Edward. 2016. *Mozart's Music of Friends: Social Interplay in the Chamber Works*. Cambridge: Cambridge University Press.

Kotovsky, Kenneth, and Herbert A. Simon. 1973. "Empirical Tests of a Theory of Human Acquisition of Concepts for Sequential Patterns." *Cognitive Psychology* 4 (3): 399–424.

Kramer, Jonathan. 1988. *The Time of Music: New Meanings, New Temporalities, New Listening Strategies*. New York: Schirmer.

Krebs, Harald. 1999. *Fantasy Pieces: Metrical Dissonance in the Music of Robert Schumann*. New York: Oxford University Press.

Lerdahl, Fred, and Ray Jackendoff. 1983. *A Generative Theory of Tonal Music*. Cambridge, MA: MIT Press.

London, Justin. 2012. *Hearing in Time: Psychological Aspects of Musical Meter*. 2nd ed. New York: Oxford University Press.

Mirka, Danuta. 2009. *Metric Manipulations in Haydn and Mozart: Chamber Music for Strings, 1787–1791*. New York: Oxford University Press.

Palmer, Caroline, and Carol L. Krumhansl. 1990. "Mental Representations for Musical Meter." *Journal of Experimental Psychology: Human Perception and Performance* 16 (4): 728–41.

Restle, Frank, and Eric R. Brown. 1970. "Serial Pattern Learning." *Journal of Experimental Psychology* 83 (1): 120–25.

Rothstein, William. 1989. *Phrase Rhythm in Tonal Music*. New York: Schirmer.
———. 2011. "Metrical Theory and Verdi's Midcentury Operas." *Dutch Journal of Music Theory* 16 (2): 93–111.
Santa, Matthew. 2020. *Hearing Rhythm and Meter: Analyzing Metrical Consonance and Dissonance in Common-Practice Period Music*. New York: Routledge.
Sullivan, James. 2021. "Metric Manipulations in Post-Tonal Music." *Music Theory Spectrum* 43 (1): 123–52.
Temperley, David. 2001. *The Cognition of Basic Musical Structures*. Cambridge, MA: MIT Press.
———. 2003. "End-accented Phrases: An Analytical Exploration." *Journal of Music Theory* 47 (1): 125–54.
———. 2024. "Melodic Pattern Repetition and Efficient Encoding: A Corpus Study." *Empirical Musicology Review* 18 (2): 97–116.
Temperley, David, and Christopher Bartlette. 2002. "Parallelism as a Factor in Metrical Analysis." *Music Perception* 20 (2): 117–49.
Tetzel, Eugen. 1921. "Der Grosse Takt." *Zeitschrift für Musikwissenschaft* 3: 605–15.
Vitz, Paul C., and Thomas C. Todd. 1969. "A Coded Element Model of the Perceptual Processing of Sequential Stimuli." *Psychological Review* 76 (5): 433–49.
Zak, Nathaniel, David Temperley, and Peter Pfordresher. 2025. "Interval Patterns Facilitate Short-Term Encoding of Melodic Sequences." *Music Perception*. https://doi.org/10.1525/mp.2025.2476514.

Music Theory Spectrum, Vol. 48, No. 2, pp. 342–358, ISSN 0195-6167, electronic ISSN 1533-8339.
https://doi.org/10.1093/mts/mtag002