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A Context-Sensitive Analysis of the Pre-Dominant Function

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ABSTRACT: Although the pre-dominant function is a key concept in music theory, its role in relation to formal context is not well understood. Further, while descriptions of pre-dominant chords as "strong" or "effective" can readily be found, the source of these claims has not yet been investigated empirically. In this article, we examine the pre-dominant function and the concept of pre-dominant strength through the lens of chord frequency within formal contexts. We catalogued chords approaching the dominant harmony (V) in the sonata-form movements of Mozart's piano sonatas, a ubiquitous repertoire in theory textbooks. Using this newly created dataset, we examine frequencies of chords that appear prior to the dominant and test whether these frequencies differ by formal location. We propose a theory of pre-dominant strength as tied to cadential dominants and share data on chord successions within the pre-dominant function. Finally, we discuss differences between approaches to V in expositions and recapitulations, highlighting harmonic amplifications that we term "pre-dominant power ups." Throughout, we illustrate that strong pre-dominant harmonies, especially rare ones, are perceptual markers of formal location at various levels within sonata form.

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1. Introduction

[1.1] Despite the many novel developments in North American music theory over the last century, harmonic function remains a mainstay in research and pedagogy. It is almost axiomatic in theories of 18th- and 19th-century Western tonal music that harmonies are grouped into three functions: tonic, pre-dominant, and dominant.(1) As the authors of *Open Music Theory* write, "the function of a chord concerns the notes that belong to it (its *internal characteristics*), the chords that tend to precede and follow it, and where it tends to be employed in the course of a musical phrase" (Shaffer, Hughes, and Moseley 2014, "Harmonic functions"). Yet among these three functional categories, the pre-dominant is notable for encompassing a range of chords that do not share a unified set of internal characteristics but rather vary widely in scale degrees, chord quality, and cardinality. Indeed, when it comes to the pre-dominant function, some music theorists stress its syntactical

placement as "dominant preparation," to the exclusion of other factors.[(2)] Our study provides a systematic investigation of the pre-dominant function, which we first operationalize as "chords occurring before the dominant."

[1.2] It is not only membership in the pre-dominant function that has received much theoretical debate; syntax within the function has also been described in different ways. Some theorists invoke the frequency of certain patterns to explain chord succession, though usually without reference to precise data about specific repertoires. For example, claims such as "before proceeding to V, IV may be followed by ii^6 (the reverse—ii^6 followed by IV—is far less common)" (Burstein and Straus 2016, 149) often appear in pedagogical texts, and frequency is also referenced in descriptions of approaches to V in schema theory (Byros 2012) and form theory (Caplin 2024). Other explanations for pre-dominant syntax rest on impressions of chord strength, effectiveness, and intensity. For example, when describing augmented sixth chords, Clendinning and Marvin write, "Occasionally, composers will write all three types [of augmented sixth chords] in quick succession to *intensify motion to the dominant* at a cadence—usually in the order Italian, French, German" (Clendinning and Marvin 2016, p. 686, emphasis added). And among his reasons why the supertonic is an "effective pre-dominant," Laitz writes that "the progression ii–V–I is often set to $\hat{2}$–$\hat{7}$–$\hat{1}$ in the soprano, versus the less dynamic $\hat{1}$–$\hat{7}$–$\hat{1}$ when IV functions as the pre-dominant" (2008, 283)." Thus, the syntactical ordering of chords within the pre-dominant function involves several different factors.

[1.3] Moreover, a relationship between pre-dominant function and large-scale form has been suggested but not fully explored in theoretical writings. In his influential study of classical form, William Caplin posits that the pre-dominant is a "fundamental harmonic function" within a "complete cadential progression" (1998, 27; rephrased in Caplin 2013, 4), a refinement of Leonard Meyer's observation: "I cannot satisfactorily explain why the progression from subdominant to dominant specifies a tonal center. … It is enough to recognize that the progression does perform this function" (1989, 275). More recently, Caplin describes differing approaches to the dominant depending on cadence type (2024, 104). Beyond the phrase level, however, the role of the pre-dominant is underexplored, including in sources that address sonata form, such as textbooks (Laitz 2012; Burstein and Straus 2016; Kostka, Payne, and Almén 2018; Clendinning and Marvin 2021), corpus studies (Sears 2016), and treatises on sonata form (Rosen 1988; Caplin 1998; Hepokoski and Darcy 2006; Greenberg 2022). Further, while pre-dominant chords are regularly spotlighted in harmony texts, their contextual placement within complete works is rarely discussed. For instance, Burstein and Straus's claim that "in eighteenth-century music, augmented sixth chords frequently precede the dominant harmonies of climactic cadences" (2016, 288) is suggestive of a connection between harmonic function and form, as is Clendinning and Marvin's observation that these chords "are usually positioned to emphasize the arrival of a particularly significant dominant harmony" (2021, 588); in both cases, examples of such moments are left for the student to discover. There seems, then, to be general agreement that the pre-dominant function differs from one location to the next within specific musical forms, yet this observation remains at the level of intuition.

[1.4] The present study addresses existing ambiguities in the literature on the pre-dominant function through a systematic and context-sensitive exploration of approaches to the dominant by cadence type and locations within sonata form. This particular repertoire was selected because it has been (and currently remains) ubiquitous in North American theory pedagogy.[(3)] That is, we reckoned that theoretical writings about syntactical orderings implicitly refer to this canonical repertoire. Further, in the sizable body of literature on Mozart's style (including Rosen 1988; Solomon 1995; Ivanovitch 2011; and Burnham 2012), we note an absence of generalized discussions about the role of the pre-dominant in relation to formal procedures. Our study addresses this lacuna by investigating the interaction of pre-dominant frequency and sonata form within a single corpus of music, laying the foundation for future comparative studies. To our knowledge, our dataset is the first to combine harmonic approaches to the dominant along with their relationship to cadences and formal locations. We employed an expert-annotated approach, which allows for the consideration of various textures that are ubiquitous in Mozart's piano sonatas.[(4)]

[1.5] We use our dataset to address three interrelated contextual issues: qualitative feelings of strength, syntax within the pre-dominant, and the role of the pre-dominant in closure and large-scale form. Two passages from Mozart's K. 545/i, a staple composition found in music theory texts, serve to illustrate these issues (see **Example 1**).(5) In the exposition, a ii^6 chord initiates the PAC at the end of the subordinate theme, while in the recapitulation, ii^6–[vii$^{\circ 7}$]V appears at the analogous location.(6) Our study offers empirical support for the familiar claims that the pre-dominant is most utilized at such form-defining cadences, that diatonic chords precede chromatic ones before the dominant, and that the particular pre-dominant chords in Example 1 are relatively "stronger" or more "attracted" to the dominant than others. Comparing across expositions and recapitulations, moreover, reveals that the insertion of the chromatic chord found in the recapitulation of K. 545/i is common in Mozart—a move we call the "pre-dominant power up"; more than "ornamental changes" (Caplin 2013, 482), pre-dominant power ups are critical for magnifying tonal closure. Further, chromatic chords such as [vii$^{\circ 7}$]V and the augmented sixth chords occur infrequently in this dataset; such "rare pre-dominants" are reserved for form-defining cadences, and this close association between harmony and form, we suggest, might account for the overrepresentation of these chords in pedagogical texts (as described in White 2021).

[1.6] In what follows, we provide the first empirical exploration of approaches to dominant harmony, contributing to a better understanding of the pre-dominant function. Section 2 describes the dataset we created to examine the pre-dominant function. In section 3, we focus on the frequency of chords immediately preceding the dominant, illustrating that chords in that syntactical location vary based on cadence type and inter-thematic formal functions. Here, we suggest that chord frequency, combined with formal location, accounts for why some chords (and not others) are nominally pre-dominant, and we propose an empirical basis for a "strong pre-dominant" (Clendinning and Marvin 2021, 276; Peterson 2021). We also consider a possible relationship between the frequency of individual harmonies and their perceived attraction to the subsequent dominant harmony, relying on experimental data (Brown, Tan, and Baker 2021). In section 4, we investigate the syntax of multiple harmonies before the dominant and test theoretical claims about "intensification" within the pre-dominant function. Section 5 offers case studies of "rare" pre-dominants; we argue that they have perceptual and form-defining significance. Finally, section 6 considers approaches to the dominant in corresponding locations of the exposition and recapitulation, wherein we propose that pre-dominant power ups in recapitulations strengthen sonata closure and contribute to long-range perceptions of chordal strength (or attraction) to the dominant by listeners familiar with the repertoire.

2. The dataset

[2.1] To facilitate our study of the pre-dominant function, we created a dataset containing expert annotations of harmonic approaches to every dominant chord in all 22 sonata-allegro movements of Mozart's piano sonatas (16 first movements and 6 third movements).(7) The dataset tracks the three chords heard before every dominant chord in the selected repertoire, as well as the cadential status and formal location of the dominant chord. Our approach to harmonic syntax was decidedly bottom-up: we catalogued all harmonies appearing before the dominant, regardless of their categorization in pedagogical texts. We also collected the temporal profile of all chords, including their onset and duration; the analysis of this temporal data is beyond the scope of the present article and would be a fruitful avenue for future research.(8) The full dataset can be downloaded from https://doi.org/10.17605/OSF.IO/7PA6M, and a published data report, which describes the data creation process and annotation standard in greater detail, can be found in Brown, Tan, and Lin (2023). A snapshot of the dataset for all dominants within K. 545/i appears in **Example 2**. Three analysts created the dataset, with one providing an initial version while the other two reviewed the entire dataset three times each. During each round of review, discrepancies in interpretation were discussed between all analysts; some discrepancies led us to refine analytical methodologies and to revisit earlier analyses to ensure that the correct analytical method was applied consistently across the entire dataset (see Brown, Tan, and Lin 2023 for more detail).

[2.2] The dataset is formatted as an Excel table, enabling users to filter or sort data easily by column headers. Each row is structured around a single instance of dominant harmony, which is operationalized as any inversion of V (triad), any inversion of V^7, and the cadential 6/4.(9) A total of 1,129 dominants in the dataset were identified; these are displayed in Column P, in light green. In the header of this column, and in the remainder of this article, we use "V" as a shorthand for all dominant harmony types. Columns S and T provide, respectively, the measure number and local key of the dominant harmony. Column V shows the bass scale degree before the dominant.

[2.3] Columns M, J, and G, also in light green, display up to three harmonies preceding each V. In this article, we will refer to these columns as "V-1" (column M), "V-2" (column J), and "V-3" (column G), such that reading the harmonies from left to right on the spreadsheet follows their temporal appearance in the music. The V-1 notation means that it occurs directly before the dominant (one chord before the dominant), whereas V-2 is two chords before V, etc. A dash ("-") appears in these columns when the harmony before V belongs to a previous phrase or is itself a dominant harmony, which would then appear in the previous row; in other words, dashes indicate that fewer than three chords separate two instances of dominant harmony.(10)

[2.4] Columns A through E provide large-scale identifiers from cues in the score: Köchel and movement numbers, time signature of the movement, key of the movement, and large-scale formal functions (exposition, development, recapitulation). Column F lists themes, theme-like units, and post-cadential units that operate at a lower level of the formal hierarchy. The theoretical basis for these formal categories is Caplin (1998; 2013), which recognizes the possibility of multiple main themes (MT1, MT2, etc.) and subordinate themes (ST) forming MT and ST groups, where subsections of themes are separated by a cadence.(11) Caplin (1998; 2013) also provides the theoretical basis for the analysis of cadence types, shown in column U. Along with the three standard possibilities for cadences—perfect authentic cadence (PAC), imperfect authentic cadence (IAC), half cadence (HC)—we identify abandoned cadences (AC), deceptive cadences (DC), and evaded cadences (EC).(12) Further, we indicate "dominant arrival" (D arrival) when dominant harmony signals the end of a formal unit, but the final chord appears in inversion, contains a chordal seventh, is not preceded by a harmonic progression, or there is noncongruence between the harmonic arrival and the melodic-motivic arrival (Caplin 1998; 2013). In our analysis, we follow Caplin's (1998) definition of PAC, IAC, and HC with the stipulation that they contain a root-position dominant (or cadential 6/4). Finally, when a dominant harmony does not participate in any of these scenarios, an entry of "no cadence" (NC) appears in the dataset.

[2.5] Deciding whether a harmonic event is or is not a cadence and if so, what type, can sometimes be less than straightforward (cf. Neuwirth and Bergé 2015). To address this, we compared our cadence annotations to two published datasets on the Mozart piano sonatas. First is the list of HCs in Martin and Pedneault-Deslauriers's (2015) article on "Mozartean Half Cadences"; our analyses matched in all but one case.(13) We also compared our cadence annotations with those of Hentschel, Neuwirth, and Rohrmeier (2021), focusing only on K. 279/i and found partial agreement with their analyses. That is, we identified twelve cadences in the movement, while Hentschel, Neuwirth, and Rohrmeier identified twenty. For example, they analyze the V occurring in m. 3 as participating in a PAC, but we call this moment an NC, as we contend that it occurs too soon within the main theme. Similarly, they label mm. 33, 35, and 37 as PACs, but we assert that these measures follow the formal end of the subordinate theme and belong to post-cadential codettas (Caplin 1998; Clendinning and Marvin 2021). Ultimately, comparisons to these other datasets prompted us to think carefully about our analytical decisions but did not result in changes to our analyses.(14)

[2.6] Turning back to K. 545/i (excerpted in Example 1), corresponding corpus annotations for the musical passages from can be found in Example 2. Row 652 contains the final dominant within the PAC that concludes the exposition's subordinate theme, where columns J and M illustrate that the harmonies preceding the arrival of the cadential 6/4 in m. 24 are a I-ii^6 progression. Since all appearances of V receive their own row, the V^6 on the downbeat of m. 21 is in row 651. Later, row 668 contains the analogous passage in the recapitulation. This row contains the dominant that

brings the subordinate theme to a cadence, with columns G, J, and M showing the harmonies heard before the cadential 6/4: I, followed by ii^6 then [vii$^{\circ 7}$]V.

3. Analysis of V-1

[3.1] In this section, we present empirical data that suggest that the chord occurring directly before V varies by formal location. The observations we offer are not exhaustive, and we encourage readers to download the dataset to test their own hypotheses. **Example 3** illustrates that chords appearing in V-1 (column M, the position immediately preceding the dominant) differ depending on whether the dominant is at a cadence. The most frequent type of harmony in V-1 is tonic (I, I^6, i, i^6), which occurs 44.46% of the time. At a cadence, however, the most frequent harmony before V is the supertonic (specifically ii^6). This finding supports Caplin's claim that "[m]any harmony texts suggest that the subdominant triad leads most typically to the dominant. An examination of the classical literature reveals, however, that the supertonic triad in first inversion (II6) is the more characteristic pre-dominant" (1998, 24; similar statements can be found in 2024, 23 and 58). More generally, a comparison of the leftmost two columns of Example 3 confirms that the distribution of chords differs significantly depending on whether the dominant is at a cadence ($X^2(7, N = 1129) = 416.10$, $p < .001$, test assumptions met).

[3.2] **Example 4** explores the frequency of bass scale degrees occurring before all dominants in the dataset. At a cadence, $\hat{4}$ and $\sharp\hat{4}$ are most frequent, and $\hat{1}$ and $\hat{3}$ are most frequent when not at a cadence; this echoes the findings in Example 3. We used a binomial test to investigate whether these findings were significant: $\hat{1}$ is the most common scale degree before all dominants ($N = 1129$) in the dataset, occurring 388 times, but it only happens 18 times before cadential dominants, which is far less frequent by comparison ($N = 374$, $K = 18$, $p < .001$). In contrast, $\hat{4}$ occurs 246 times before all dominants (21.79% of $N = 1129$), but it is the most common scale degree before cadential dominants, occurring 194 times (51.87% of $N = 374$, $K = 194$, $p < .001$). Our investigation of scale degrees can also be used to test theoretical claims. For example, Caplin (1998, 24) states that [vii$^{\circ 7}$]V is the most typical chord with $\sharp\hat{4}$ in the bass, and we found this to be true: of the 76 occurrences of $\sharp\hat{4}$ before all dominants, [vii$^{\circ 7}$]V appears most often at 31 times, followed closely by [V$^6_5$]V, which occurs 21 times.

[3.3] Returning to Example 3, one might use these data to suggest that the pre-dominant function can be defined as chords that occur most frequently before a cadential V. This would lead us to conclude, however, that tonic chords (comprising 8.29% of V-1 chords at a cadence, shown in the middle column of Example 3) are more representative of the pre-dominant function than an augmented sixth chord (comprising 6.68% of V-1 chords at a cadence). This would contradict common theoretical understandings: the tonic chord is not generally understood as a pre-dominant, let alone a strong representative of that concept. However, instead of considering chord's overall frequency at a cadential V we might instead measure the extent to which a V-1 chord *predicts* a cadence, and use this to define the pre-dominant function. **Example 5** presents the data from Example 3 in a slightly different way, this time illustrating the percentage with which a V-1 chord leads to a cadential V. Now, the augmented sixth receives the highest percentage. That is, when an augmented sixth appears in V-1, it leads to a cadence 75.76% of the time. There are five V-1 chord categories that result in a cadence at least 50% of the time (from most to least frequent): augmented sixths, applied leading-tone chord of V, supertonic, applied dominant of V, and subdominant; all of these are nominally "pre-dominants" as understood by music theorists and are most representative of the function. Other chord categories, such as tonic, do not often lead to a cadential V.(15)

[3.4] The top five rows in Example 5 list the chords that are often referred to as pre-dominant in theoretical discourse; our data suggest that what theorists describe as a pre-dominant is a chord that, more often than not, leads directly to a cadential dominant. For example, Aldwell and Schachter write that "IV, ii, and their derivatives" are "particularly well suited to *lead into and intensify the dominant harmony*" (2003, 126, emphasis original). Moreover, we also note that the percentages in Example 5 reveal a hierarchy, whereby some chords lead to a cadential V less

frequently (e.g., subdominants) and others are reliable signals of impending cadential closure (augmented sixths). Returning to the distinction that many authors propose between "strong" pre-dominants and weaker ones (Clendinning and Marvin 2021, 276; Peterson 2021), we suggest that the likelihood with which a chord leads to a cadential V is a compelling factor for the definition of a strong pre-dominant and provides an empirical basis for this range of strength.

[3.5] Examples 3 and 5 can also be used to better understand the submediant, a chord that is often described in textbooks as both a pre-pre-dominant (e.g., Laitz 2012, 269; Burstein and Straus 2016, 187) and a tonic substitute. Other textbook authors (Clendinning and Marvin 2021, 307) and musically trained study participants in White (2023, 168) categorized the submediant as a pre-dominant. Example 3 illustrates, however, that the submediant never occurs in V-1 at a cadence. This finding either provides empirical evidence for Caplin's stance that the submediant is not a pre-dominant harmony (2013, 10), or that the submediant, at least in this particular dataset, is an extremely weak pre-dominant, never leading to a cadential dominant.

[3.6] Let us bring the foregoing observations into dialogue with the perceptual findings from Brown, Tan, and Baker (2021). There, participants heard 31 trials, each consisting of a four-event Shepard-tone sequence: a tonic note, some variable chord, the dominant triad, and then the tonic note, where the variable chord was a harmony other than $V^{(7)}$. Participants rated the level of attraction of the V-1 chord to the dominant chord on a scale from 1 to 7, with 7 being most attracted. The chords heard as V-1 ranged from tonic to an augmented sixth chord; these 31 chords are on the x-axis of **Example 6**. This example also includes mean ratings for each of the chords by two groups of participants: junior/senior music majors from the Peabody Conservatory of the Johns Hopkins University (shown with the black diamonds in the example) and a group of participants with little musical training (from the online recruitment platform Prolific.co, shown with grey circles). Chord attraction ratings from the nonmusician participants are generally flatter, whereas ratings from the music students are more varied. The experiment found that musicians' ratings tend to correspond to textbook descriptions of pre-dominant chords: lower ratings were given to tonic and mediant, whereas higher ratings correspond to chords such as ii and augmented sixths. Further exploration from the musicians' responses revealed that semitonal voice leading between a chord and the subsequent dominant, and presence of $\hat{4}$ and $\hat{6}$, led to higher attraction ratings.

[3.7] To explore the relationship between frequencies of chords before V in our dataset and attraction ratings of chords before V from the experiment, we performed Spearman rank correlations (hereafter referred to as "correlations").(16) For the junior/senior musician participants, the correlation between attraction ratings and the number of times that the chord leads to a cadential V is .655 ($p < .001$); these data can be observed in Example 6. This suggests that even when listening to an abstract chord sequence, music students seem to be using internalized knowledge of classical music (perhaps even a "Mozartian template"), including the likelihood of a given chord leading to a cadential dominant, to inform their perceptions of chordal attraction to V. It seems that the musician participants have learned, implicitly or otherwise, syntactical regularities from this repertoire that is highly represented in textbooks (e.g., Saffran et al. 1999; White 2021). In contrast, the correlation between chord attraction ratings by nonmusicians and the frequency with which each of these chords moves to a cadential V is low and nonsignificant ($\varrho = .221$, $p = .255$). Nonmusicians' judgments of the attraction of chords as they move to V are not informed by chord frequencies in the Mozart dataset, and they may have been responding with another musical style in mind altogether (Vuvan and Hughes 2019).(17)

[3.8] Finally, since [3.1] found that the V-1 chord differs depending on whether V belongs to a cadential progression, we speculated that such approaches might also vary by the location of these cadences within larger forms. The dataset allows us to study the approach to V in various locations within sonata form. **Example 7** illustrates broad categories of chords in the V-1 position at the cadential close of main themes (MT1 and MT2), transitions (TR), and subordinate themes (ST1, ST2, ST3), combining both expositions and recapitulations. Importantly, there is a complete lack of chromatic chords in V-1 (applied of V and augmented sixths) at the end of main themes.(18) Instead, the most frequent V-1 at the end of MTs and STs is the diatonic supertonic chord, which is consistent with our finding that the supertonic is the most frequent type of V-1 before cadential

dominants overall (see [3.1]). In contrast, we see that at the final cadence of the transition, chromatic chords (primarily applied of V chords) are used most frequently in V-1.[(19)] Despite their overall infrequency in the corpus, these chromatic chords serve as strong aural markers of the medial caesura.[(20)] This usage also might, in turn, contribute to musicians' perceptions of chordal attraction to V that was observed in Brown, Tan, and Baker (2021).

[3.9] Turning to an analysis of bass notes in V-1 at cadences ending MT, TR, and ST, $\hat{4}$ is overwhelmingly the bass scale degree prior to $\hat{5}$ at the end of main and subordinate themes, occurring in 76 of 120 cadences (see **Example 8**). Thus, the supertonic that commonly appears in V-1 at the end of MT and ST is often in first inversion. In contrast, $\sharp\hat{4}$ is the most frequent bass scale degree leading to $\hat{5}$ at the end of TR. These findings add data to Hepokoski and Darcy's claim that the half cadence at the end of TR is "often approached through a chromatically altered predominant harmony that contains $\sharp\hat{4}$" (2006, 30). These data also support Caplin's description of the pre-dominant in general: "The large number of pre-dominant harmonies in a key generally relate to one of two main types—those built above the fourth degree of the scale and those derived from the dominant of the dominant (V/V)" (1998, 23; see also 2013, 10); our empirical findings add formal locations to this description. They suggest that pre-dominant harmonies differ by cadence type and formal location, acknowledging that cadences in our dataset are tied to sonata form: that is, all transitions in this dataset end with an HC, either in tonic or the subordinate key, and most MTs and STs end with a PAC.

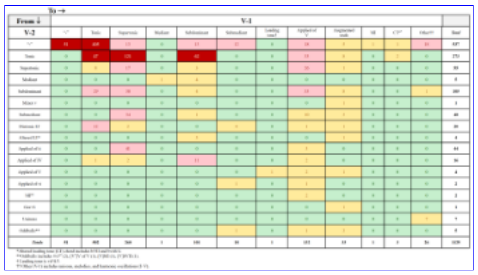
[3.10] **Example 9** provides an analysis of harmonic approaches to the final dominant at primary formal markers within sonata form, now illustrating V-1 at section-ending cadences of MT, TR, ST, and also codettas, developments, and codas.[(21)] It echoes similar findings in Example 7: the MT never ends with any chromatic chords in V-1; the supertonic is most frequent in V-1 at the end of the MT and ST; and applied of V chords are most frequent in V-1 at the end of the TR. It additionally shows several other connections between specific harmonies and formal zones. At the end of codettas and codas, for instance, the tonic chord is most frequent in V-1. Turning to the development section, the cadence on V at the end of the development in the tonic key is most often preceded by an applied chord of V.[(22)] However, in developmental passages moving to the submediant key, the most normative chord prior to the submediant's dominant is the augmented sixth chord, despite its rarity in the dataset overall (constituting only 2.92% of all V-1 chords in the dataset). The concentration of augmented sixth chords at this moment suggests a possible connection between these chords and their role in development sections, although larger datasets are needed to explore this further; it may also be that this finding is limited specifically to Mozart's piano sonatas. Still, the rightmost column of Example 5 reminds us that the augmented sixth points to a cadence at a higher percentage than any other chord type, suggesting a source for the theoretical interest often given to these chords (Harrison 1995). Section 5 of this article further investigates these infrequent ("rare") pre-dominants.

4. Examining two-chord successions before V

[4.1] Let us now widen our focus to explore transitional frequencies of the two chords occurring before V, that is, from V-2 (column J) to V-1 (column M). This helps us to learn about the syntax of multi-chord approaches to V and to investigate an empirical basis for claims made by theorists about the intensification that occurs within the pre-dominant area. In this section, we continue to explore the notion of strong and weak pre-dominants, now based on chord ordering. **Example 10a** displays a heatmap showing the raw frequency of all chord transitions from V-2 to V-1 in the entire dataset, illustrating how often two chords occur together before all 1129 dominants.[(23)] Recall that tonic is the most frequent chord in the V-1 position; consistent with this finding, Example 10a

Example 10. (A) Heatmap illustrating the frequency of transitions from the chord occurring two chords before V ("V-2" on the y-axis) to one chord before V ("V-1" on the x-axis) in the dataset. (B) Heatmap illustrating the frequency of transitions at cadences from V-2 (y-axis) to V-1 (x-axis) in the dataset.

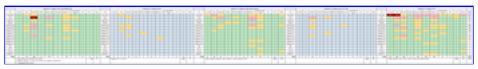
illustrates that the most common approach to any V in the dataset involves tonic. Among the most frequent are "-" to the tonic chord (n = 405), tonic to supertonic (n = 121), tonic to subdominant (n = 62), and tonic to tonic (n = 47); as a reminder, "-" in the dataset means that the chord in that position belonged to a previous row or phrase.[24] The heatmap in **Example 10b** now focuses on the frequency of V-2 to V-1 transitions at cadential progressions alone. The most frequent successions prior to the 374 cadential dominants are tonic→supertonic (n = 93), tonic→subdominant (n = 45), and subdominant→applied of V (n = 25).[25] As discussed in section 3, the most common V-1 chord at a cadence is the supertonic. Example 10b builds upon this to illustrate that the chords most frequently preceding the supertonic are tonic, submediant, and then subdominant, in that order.



(click to enlarge and see the rest in a new tab)

[4.2] Building on findings of V-1 chords before various cadences described in section [3.9], **Example 11** shows that the V-2 to V-1 approaches to the dominant also differ by cadence type. In particular, the most common two-chord approach to V before a PAC (and elided PAC) is tonic→supertonic (n = 60), with tonic→subdominant as the second-most common (n = 31). In contrast, HCs and non-cadential arrivals on the dominant (D arrivals) are most frequently approached by supertonic→applied of V (n = 19) or subdominant→applied of V (n = 16). Thus, textbook descriptions of pre-dominant expansions (Laitz 2008, 540, 545; Clendinning and Marvin 2021, 403) reflect Mozart's default strategy when approaching HCs and D arrivals but not when approaching a PAC—a detail that is not explicitly addressed in these texts.

Example 11. Heatmap organized by cadence type, illustrating progressions between all V-2 (y-axis) to V-1 (x-axis) chords.



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[4.3] We can also use findings from the dataset to test specific claims about pre-dominant expansions found in theory textbooks. One oft-repeated claim involves the chords IV and ii, for which the diagram in Kostka and Payne (2009, 111), with a solid arrow directed from IV to ii, is emblematic; see **Example 12**. In [1.2] we noted Burstein and Straus's similar observation, which is echoed both by Laitz, "the goal-oriented melodic motion in the succession IV–ii$^{(6)}$ is very common" but "the weaker motion of ii–IV is not" (2008, 291), and Clendinning and Marvin, "when two strong predominant harmonies appear in succession before moving to V, they do so in a descending-third root progression: IV to ii (and not the other way around)" (2021, 276). While the specific rationale for why ii follows IV differs in these texts, our data support the assertion that IV–ii$^{(6)}$ is much more common than the reverse. As shown in Examples 10a and 10b, subdominant chords lead to supertonic chords 30 times, while supertonic chords lead to subdominant chords a mere 3 times (and never at a cadence). Example 11 also illustrates that the location of the subdominant→supertonic progression is mediated by cadence type. That is, the progression is more frequent at authentic progressions (12/200 = 6.00%) than at half cadences and D arrivals (4/130 = 3.08%) and is even less common at non-cadential dominants (9/751 = 1.20%).

[4.4] Descriptions of pre-dominant "expansions" (Clendinning and Marvin 2021, 307) or "complexes" (Laitz 2008, 290–291) of multiple non-tonic chords leading to V often imbue the V-1 position with qualities of strength and attraction. Clendinning and Marvin, for instance, suggest that "the most common role for V^7/V or V/V in the basic phrase is to replace or follow a predominant-function harmony […] You could think of V^7/V as a *supercharged* ii^7" (2021, 403, emphasis added). They also write that the Neapolitan sixth and augmented sixth chords "characteristically share the same position in the basic phrase: as chromatic predominant chords that intensify motion to V" (2021, 577). Our findings provide empirical support for this impression: diatonic chords often described as being pre-dominant in function (e.g., IV, ii) move to a chromatic chord (i.e., applied of V, augmented sixth) 96 times in the dataset, and never in the reverse order.[26] This suggests a diatonic-to-chromatic pre-dominant chord schema that could be more explicit in textbook guidelines of pre-dominant expansions and is not captured within the well-known chord-succession diagram in Example 12 from Kostka and Payne (2009, 111).

[4.5] Clendinning and Marvin's observation about applied dominants as supercharged pre-dominants that follow diatonic pre-dominants is related to Caplin's claim that within cadential progressions, "the most frequently employed embellishment of pre-dominant function appears over ♯$\hat{4}$ in the bass voice" (2013, 16–17; see also 1998, 26–27, and 2024, 58), that is, within the bass line $\hat{4}$–♯$\hat{4}$–$\hat{5}$ (c.f. Caplin 2024, 105). We find strong evidence for this in our dataset. **Example 13** provides a detailed summary of the resolutions of the seven most frequent chords in V-2, differentiated by mode and inversion. When $\hat{4}$ is in the bass in V-2 (i.e., IV, iv, and ii^6), over a third (37 of 104) of chords in the subsequent V-1 position have ♯$\hat{4}$ in the bass voice; and all of these 37 progressions lead to cadences (28 HCs, 8 PACs, 1 EC). Echoing the finding from [3.1] that ii^6 is the most common chord in position V-1 at cadences, this example also suggests that $\hat{4}$–♯$\hat{4}$–$\hat{5}$ is likewise most often initiated by a ii^6 chord, not IV. That is, when IV is in the V-2 position, it is most frequently followed by I^6, whereas ii^6 in the V-2 position is most frequently followed by [V$^6_5$]V (see Example 13). Whereas Clendinning and Marvin state that IV and ii "can substitute for one another" (2021, 276), these data illustrate that the chords are not functionally equivalent, at least in Mozart's piano sonatas. Further, when ii6 is followed by a chromatic predominant such as [V$^6_5$]V, this pair of chords is highly predictive of a half cadence (see Example 11); this supports Robert Gjerdingen's discussion of the "converging cadence," a type of half-cadence schema in which the outer voices move towards one another often with $\hat{2}$–$\hat{1}$–$\hat{7}$ in the upper voice and $\hat{4}$–♯$\hat{4}$–$\hat{5}$ in the bass (2007, 159). Put another way, when ii^6 is in the V-1 location, it is very likely to lead to a PAC and not an HC (leading to a PAC 81 times and to an HC only 13 times). When it is in the V-2 location, however, it is more predictive of an HC (leading to a PAC only 6 times and an HC 18 times), and in each of these HCs, the V-1 is a chromatic pre-dominant with ♯$\hat{4}$ in the bass.

Example 13. The seven most frequent V-2 chords (first leftmost column) and their minor-mode counterparts if present in the dataset (in grey), followed by subsequent V-1 frequencies (third column). All chords in V-2 are presented in descending order of frequency, based on major-mode appearances. All chords in V-1 are presented in descending order of frequency.

V-2 Chord	Total	V-1 Chord	Count	Percentage
I^6	135	ii^6	55	40.74%
		IV	35	25.93%
		I	21	15.56%
		[vii^{ø7}]V	7	5.19%
		ii	6	4.44%
		IV^6	3	2.22%
		ii$^{6/5}$	2	1.48%
		CT^{ø7}	2	1.48%
		ii^7	1	0.74%
		ii$^{4/3}$	1	0.74%
		[V^7]V	1	0.74%
		[vii^{ø7}]V	1	0.74%
i^6	10	ii^{ø6}	2	20.00%
		iv	2	20.00%
		Ger+6	2	20.00%
		i	1	10.00%
		[V^7]V	1	10.00%
		[vii^{ø7}]V	1	10.00%
		Fr+6	1	10.00%
I	106	ii^6	37	34.91%
		I^6	23	21.70%
		IV^6	10	9.43%
		IV	8	7.55%
		ii	7	6.60%
		ii^7	4	3.77%
		IV$^{6/4}$	4	3.77%
		[vii^{ø}]V	4	3.77%
		[V$^{4/3}$]V	3	2.83%
		ii$^{6/5}$	2	1.89%
		[vii^{ø6}]V	2	1.89%
		[V$^{6/5}$]V	1	0.94%
		[vii^{ø7}]V	1	0.94%

(click to enlarge and see the rest in a new tab)

[4.6] The dataset can also be used to support additional claims in schema theory. For example, Vasili Byros (2012) discusses the *le-sol-fi-sol* schema in detail, describing it as having "attraction to the dominant" (292), exhibiting "cadential function" (295), and occurring in "highly charged, dominant-orientated situations" (297). Byros shows that the progression leads to an HC 62% of the time in his corpus (as opposed to a PAC 18% of the time), and we found similar evidence that the schema typically leads to an HC (70% of the time in our dataset). Like Byros (297), we also observed these appearances at form-defining events within sonata form, primarily at the medial caesura and within retransition passages. Such appearances of the schema at these particular moments support Byros' argument that the schema has a strong key-defining profile (314), as it is designed to prepare one's ear for the new tonic in the section that follows.

[4.7] Finally, we can test the claim that vi in the V-2 position often leads to IV, ii^6, or ii$^6_5$ (Burstein and Straus 2016, 187; Forte 1979, 95). Example 13 illustrates that of the 32 instances of vi occurring in V-2 in our dataset, over 70% lead to ii^6 (and far less frequently to IV and ii$^6_5$), suggesting a slight refinement to this claim. Focusing on the role of the submediant as V-2 at cadential progressions, the submediant→supertonic transition is most likely to lead to a PAC (n = 14) rather than to any other cadence or NC (Example 11). And while the submediant in the V-2 position does infrequently lead to the subdominant, this never happens at a cadence. Overall, when comparing all V-2 to V-1 approaches to the dominant, the submediant→supertonic approach to V is the most common

succession involving non-tonic chords. This is consistent with the frequent claim that the circle-of-fifths progression underlies tonal harmony; Kostka and Payne suggest, for instance, "The root position of a 5th down (or 4th up) is *the most basic progression in tonal harmony*, whether or not it occurs in the context of a sequence" (2009, 106, emphasis added). And yet, the submediant→supertonic progression plays a limited role in this dataset, occurring before only 7.9% of PACs.

5. Case studies of "rare" pre-dominants

[5.1] Earlier, we proposed that strong pre-dominants are those that most likely lead to a cadential dominant (Example 5), and that musicians have internalized these frequencies (Example 6). As mentioned above ([3.10]), the strongest type of pre-dominant, the augmented sixth, occurs infrequently in the dataset, making up only 2.92% of all chords in the V-1 position (Example 3) and only 6.68% of chords before cadences. And yet, these chromatic sonorities are the recipient of much theoretical attention (Harrison 1995) and pedagogical emphasis, including dedicated chapters in many music theory textbooks (Laitz 2008; Kostka and Payne 2009; Burstein and Straus 2016; Clendinning and Marvin 2021). Indeed, White (2021) finds that augmented sixth chords are disproportionately overrepresented in pedagogical texts in comparison to their frequency in the repertoire (as queried in the Yale-Classical Archives Corpus). With White's and our findings in mind, this section explores the significance of these chords and proposes a "rare pre-dominant hypothesis." Inspired by Richmond Browne's "rare-interval hypothesis" (1981), which suggests that rare intervals such as the semitone and tritone have significant perceptual weight for listeners of tonal music, we speculate that relatively less-frequent pre-dominants like augmented sixths are particularly salient for classically trained musicians because they reliably occur at form-defining moments. Our "rare pre-dominant hypothesis" argues that these chords are perceived as strong not only because of the likelihood with which they will lead to a cadence (Example 5), but also because of their orienting role in sonata form. This, in turn, could be the source of the overrepresentation of such chords in theoretical and pedagogical discourse. In this section, we explore the possible association of the rare pre-dominants ♭II, augmented sixth, and mode-mixture chords with particular formal locations, suggesting that it is the combination of their placement and relative infrequency that makes them noteworthy.

[5.2] As shown in **Example 14**, there are just 36 instances of augmented sixth chords (It^{+6}, Fr^{+6}, and Ger^{+6}) in the entire dataset (with the vast majority, 33 out of 36, occurring in the V-1 position). Augmented sixths occur 6 times in the exposition (always in TR or ST, never in MT or Codetta), 19 times in the development, and 11 times in the recapitulation (also always in TR or ST, never in MT or Codetta). We found that while the augmented sixth is infrequent as a V-1 harmony, it is often tied to a specific formal role, occurring mostly at D arrivals or HCs that signal the arrival of new keys (i.e., closing the TR or development). Moreover, the augmented sixth is often found prior to the arrival of V in vi within development sections. That is, of the 20 major-mode movements in our dataset, 13 have a goal of V in the key of vi within the development (before the D arrival in the tonic key that leads to the recapitulation), and an augmented sixth chord is found approaching V of vi in *all but three* of them.(27) While David Beach (1994) has noted similarities of the developments in K. 280/i and K. 332/i, including that both feature arrivals in V of vi that are preceded by an augmented sixth, our systematic study suggests that this association between the augmented sixth chord and the arrival of V in vi within the development extends far beyond these two F major sonatas, illustrating a more predictable role for this chord than has previously been discussed in theoretical literature.(28) Returning to the quotes in [1.3], our findings clarify why augmented sixth chords are thought to be reserved for "climactic cadences" (Burstein and Straus 2016, 288) and "particularly significant dominant harmonies" (Clendinning and Marvin 2021, 588), specifying the locations of those special moments. Further, that there are more augmented sixth chords in recapitulations than expositions (Example 14) may contribute to a long-range perceptual schema whereby the augmented sixth is a signal of the impending end of the movement.

[5.3] Turning to the connection between augmented sixth chords and cadences, we also observe that these chords frequently point to an HC, as 24 of its 36 instances are prior to an HC (the other

appearances of augmented sixths in the dataset occur 9 times at an NC, and just 3 times at a PAC). Looking specifically at the V-1 position, a binomial test suggests that while the augmented sixth only makes up 2.92% of chords before all Vs in the dataset ($N = 33$, $K = 1129$), it is concentrated before dominants within half cadences ($N = 22$, $K = 111$, proportion = 19.82%, $p < .001$), making it a reliable predictor of an HC. Interestingly, while textbooks claim that the Ger^{+6} should resolve to the cadential 6/4, only 4 of these 25 chords do so.(29) The other 21 move directly to $V^{(7)}$. Perhaps this direct motion to $V^{(7)}$ serves to make the dominant arrival more declamatory. In sum, these data can bring new understandings to the augmented sixth (and the German augmented sixth in particular): the most common augmented sixth chord in the dataset is the Ger^{+6}, which most often leads directly to V at an HC (and not a cadential 6/4), and its most frequent formal location is at the end of the development section marking the cadence in the key of vi. These findings also provide one possible empirical source for why the music students in Brown, Tan, and Baker (2021) rated the Ger^{+6} in particular as the harmony most attracted to V.

[5.4] The Neapolitan chord is even rarer than the augmented sixth chord, occurring just 3 times in the dataset. Each occurrence, however, involves an important V arrival: once in V-1 in the development of K. 570/i (before the arrival of V of vi in m. 95), and twice in the V-2 position, where it is followed by an applied dominant of V (one instance is in K. 284/i, before the development's V pedal starting in m. 70, and the other is in K. 457/i, approaching V in m. 126 of the recapitulation's last cadence in TR). These latter two occurrences support the abstract examples of the Neapolitan moving to an applied dominant of V in Clendinning and Marvin (2021, 579) and Kostka and Payne (2009, 382). While few in number, these occurrences from the dataset suggest a possible formal and rhetorical role for the Neapolitan chord that might be more prominent in other repertoires.

[5.5] Finally, mode-mixture chords are also infrequent in the dataset but seem to be reserved for rhetorical emphasis connected with the pre-dominant function. For example, in a chapter on mode mixture, Laitz writes, "Once you introduce modal mixture, continue its use until you reach the dominant function. This is because $\flat\hat{3}$ and especially $\flat\hat{6}$ possess such powerful drives to $\hat{2}$ and $\hat{5}$, respectively, that any intrusion of their diatonic forms would not only create a jarring cross relation but also ruin the drive to the dominant" (2008, 623). We examined the dataset for mode mixture—borrowing from the parallel minor—to learn whether it is mediated by formal location in this repertoire. Within the 20 major-mode sonata-form movements within the dataset, there are 26 instances of borrowing from the parallel minor. **Example 15** summarizes these instances and their locations. As expected, mode mixture is prominent in the development section, with many examples occurring at the beginning of the development or shortly before the dominant's arrival in the tonic key. This use of mode mixture plays into the *Sturm und Drang* topic of the development (Caplin 2005) and the contrast of major/minor elements that mark classical retransitions (Spitzer 1996, 26–27), which often precede the development's ultimate arrival on V. Our case study also illustrates an increased use of mode mixture from the exposition (5 instances) to the recapitulation (10 instances), with the biggest increase in the ST area.(30) This finding suggests that Mozart employs mode mixture similarly to augmented sixths: as a rhetorical strategy before closure. That said, we acknolwedge the relatively small size of our dataset. Thus, future research might examine possible connections between less frequent, "rare," pre-dominants (e.g., augmented sixths, Neapolitans, mode mixture) and their formal implications in larger corpora.

6. The Pre-Dominant Power Up

[6.1] Theorists of sonata form have discussed a tendency for recapitulations to become more chromatic relative to expositions (Rosen 1988; Hepokoski and Darcy 2006), and the previous section noted a modest increase of augmented sixth (Example 14) and mode mixture chords (Example 15) in recapitulations. Looking more broadly at the dataset, we note that while 13.54% of V-1 chords in the exposition are chromatic, this increases to 18.68% in the recapitulation. A small portion of this growth is due to an increase of mode mixture (e.g., minor tonic is borrowed in 6 instances in the exposition and 10 in the recapitulation), where some of these new, recapitulatory minor tonics within major-mode compositions occur in passages Hepokoski and Darcy describe as "lights out" (2006, 235), such as the surprising shift from major to its parallel minor in a

recapitulation's MT (e.g., K. 309/i, m. 101). However, we also found that most of this new chromaticism in recapitulations is due to the rise of applied dominants and applied leading-tone chords: there are 50 of these chords in V-1 in the exposition and 67 in the recapitulation. Thus, our observation of the rise of this chromaticism is distinctly different from the tendency for recapitulations to move to IV and related "flat" keys (Rosen 1988, 289; Hepokoski and Darcy 2006, 265).

[6.2] Recall from section [1.5] and Example 1 our introduction to the "pre-dominant (PD) power up," whereby a weaker chord before V from the exposition of K. 545/i is replaced with a stronger one (as defined by the hierarchy in Example 5) at the analogous moment in the recapitulation. While Caplin (2013, 482) also observes this intensification in the movement, no study has yet tracked long-range pre-dominant power ups from one section to its analogous section in a corpus of music. In response, we discovered that in 14 of the 22 movements in our dataset, pre-dominant chords from the exposition were intensified in some way in the recapitulation. We also noted other means of destabilization of an expositional harmony (e.g., through a change of inversion in the recapitulation).(31) Thus, we can define a pre-dominant power up more broadly as an intensification of a chord (or series of chords) before V in the recapitulation in relation to the analogous moment in the exposition; PD power ups include replacement of a diatonic harmony with a chromatic one (ii^6 in the exposition becoming [vii$^{\circ 7}$]V in the recapitulation like in Example 1), using a stronger pre-dominant in place of a weaker one (IV in the exposition becoming ii^6 in the recapitulation), inverting a chord ([V^7]IV–IV in the exposition becoming [V$^6_5$]IV–IV in the recapitulation), and/or destabilizing a sense of key by replacing a tonic chord with any other chord (I–ii^6 in the exposition becoming [vii$^{\circ 4}_3$]ii–ii^6 in the recapitulation).

[6.3] **Example 16** illustrates an example of a PD power up that occurs prior to the final V at the end of the TR in the exposition and recapitulation from K. 533/i; here, ♭VI from the exposition becomes a Ger^{+6} at the analogous moment in the recapitulation. In the power ups shown in Examples 1 and 16, no new measures are inserted in the recapitulation. In contrast, **Example 17** provides an example of a PD power up in which more beats/measures are added to the recapitulation. In the exposition, the TR-ending HC is preceded by a tonic chord lasting one beat (mm. 48–49); in the recapitulation, the tonic arrives an eighth note early in m. 183 and is then followed by a IV–[V$^6_5$]V pre-dominant expansion. Each of these examples of a PD power up inserts a chromatic chord into the recapitulation. Such power ups may have influenced textbook descriptions of chromatic pre-dominant chords as harmonies that "intensify motion to V" (Clendinning and Marvin 2021, 577); indeed, Brown, Tan, and Baker (2021) found that chords with greater semitonal attraction to V were perceived as more attracted to V by participants with music theory training. We suggest that all of these long-range harmonic modifications within similar thematic returns contribute to a sense of pre-dominant attraction to V that is stronger in the recapitulation than in the exposition.

[6.4] In contrast, we found only three instances of recapitulatory de-intensifications or "pre-dominant power downs" in the Mozart dataset. In K. 333/i, the V in m. 151 (recapitulation) is preceded by ii$^6_5$, while the V in the comparable passage from the exposition is preceded by [V$^6_5$]V (m. 49). Similarly, in K. 457/i, the V in m. 154 (recapitulation) is preceded by ii^o, substituting for [vii$^{\circ 7}$]V in the exposition (m. 57). In this example, however, two new augmented sixth chords precede dominants shortly before this progression (mm. 141, 147), such that this ST is not "powered down" in its entirety. Movement K. 283/i contains a final example of a power down, shown in **Example 18**: here, ii^6 in m. 50 (exposition codetta) is replaced with IV in m. 117 (recapitulation). Once again, while the harmony ii^6 from the exposition becomes a slightly "powered down" IV chord in the recapitulation, there are still elements of increased closure in the recapitulation, as the modification allows for downward figuration that facilitates a stepwise descent on each downbeat in the treble clef from B5 (m. 115) to G4 (m. 118), providing an added layer of rhetorical closure.(32)

[6.5] The table found in the Appendix summarizes all 29 power ups and power downs in approaches to V that were found in the dataset when comparing analogous passages in expositions and recapitulations. On average, the changes in recapitulations modify just one chord (M = 1.34 chords) from the exposition, and 20 of the 29 modifications affect at least the V-1 chord (rather than

just V-2 or V-3). Twenty-one of the 29 modifications involve no added/deleted measures between exposition to recapitulation, allowing for a direct comparison of the harmonies. We suggest that PD power ups may be internalized by listeners familiar with Mozart's sonatas, contributing to a long-range chordal-attraction schema. We note that our study of power ups does not include novel or completely recomposed passages inserted into recapitulations, of which we found 25; our study of power ups refers solely to changes in harmonies for similar passages in the exposition and recapitulation (what Hepokoski and Darcy call "correspondence measures," 2006, 239).(33)

[6.6] Of the 26 excerpts with PD power ups listed in the Appendix, 22 occur at a cadence, suggesting that these are deliberate modifications at form-defining moments in the recapitulation. None of the power ups occur in the MT, 10 occur in the TR, 14 in ST, and two in the Codetta. Further, 9 of the 10 PD power ups in the TR happen immediately before the final V: these modifications to the pre-dominant function set the stage for this important structural moment. Similarly, of the 14 PD power ups occurring in the ST, 10 are at the PAC coinciding with the final cadence ending ST, providing emphasis to the moment of the movement's essential structural closure (described as "the most significant event" within any sonata; Hepokoski and Darcy 2006, 232). These PD power ups occur almost exclusively at cadences and usually at the end of TR and ST, in passages that carry form-defining roles. Such regularity may serve to amplify power ups for listeners, as recognizable and even predictable markers of formal location. This elucidates yet another close connection between the pre-dominant harmonic function and form in the Mozart piano sonata movements.

[6.7] The Appendix also illustrates that 9 of the 10 PD power ups in the TR involve the substitution of a diatonic chord for a chromatic chord. For example, in K. 310/i, vi–ii^6 (m. 16) becomes [V^6]iv–iv (m. 97), and in K. 570/i, V^7–vi (m. 35) becomes [$vii^{\circ 7}$]vi–vi (m. 165). Likewise, half of the 12 PD power ups in ST involve the addition of a chromatic chord, such as Ger^{+6} replacing ii^6 (K. 311/i), [V^6_5]iv–iv replacing IV (K. 457/i), and [$vii^{\circ 7}$]V replacing ii^6 (K. 545/i; see Example 1). We also observe three instances of ii6 in the recapitulation replacing IV in the exposition (K. 282/iii and two instances in K. 330/iii). This provides long-range support for the oft-encountered suggestion that ii is a stronger pre-dominant than IV (sections [3.3] and [4.3]). While few in number in our dataset, we contend that claims of pre-dominant strength also derive from these small changes from exposition to recapitulation.

[6.8] While the table in the Appendix offers a relatively small sample of PD power ups from a circumscribed dataset, it nevertheless suggests a novel way of understanding harmonic syntax within the pre-dominant function, and in turn, introduces long-range attraction schemas for pre-dominant chords to V that may be acquired implicitly by those familiar with this repertoire. A larger exploration of the PD power up may reveal similar intensifications of chords before V in other formal types containing a reprise, such as da capo arias and ternary movements, and in works by composers other than Mozart. As just one example, a PD power up can be observed in Friedrich Seitz's Violin Concerto No. 5, third movement, where the $ii^{\emptyset 4}_3$ heard directly before the V in mm. 7 and 33 is replaced with a Fr^{+6} when the comparable passage returns in m. 144. It may be that the PD power up is a schema in itself, acquired by listeners through statistical learning in the same way scholars have described other schemata (Byros 2012, 309; Meyer [1967] 1994, 277), and that notions of pre-dominant strength stem from it.

[6.9] Thinking of the PD power up as a schema places it in dialogue with other schemata involving approaches to V. For example, Byros (2012, 333, fn33) writes, "That composers understood the *le-sol-fi* stage of the schema as *functionally synonymous* with an augmented sixth is evident in their **interchangeable use** of the *le-sol-fi-sol* and augmented 6–V schemata. In sonata-form movements and other rounded-binary structures, composers would substitute one schema for the other in articulating a half cadence" (bolded emphasis added). Byros then illustrates an example from Beethoven's Fourth Piano Concerto, first movement, where the *le-sol-fi-sol* schema is used in the exposition (with [$vii^{\circ 7}$]V as V-1 in m. 110 just before the medial caesura), and this schema is replaced by a Ger^{+6} in m. 280 at the corresponding section in the recapitulation. We note that this is an example of a PD power up. Thus, this replacement is not merely an interchangeable use of the

two approaches to V, as Byros suggests, but a rhetorical strategy for tonal closure in the recapitulation.

[6.10] The PD power up may be another factor influencing chord attraction ratings by the trained musicians in Brown, Tan, and Baker (2021). By noticing these small changes of PD intensification from expositions to recapitulations, listeners familiar with the classical style may acquire knowledge of PD strength and develop expectations for power ups to occur in the recapitulation. The PD power up would seem to be implicitly learned as listeners compare approaches to V between expositions and recapitulations.(34) The correlation between frequency and chord attraction ratings by musician participants in this experiment is additionally suggestive of what Byros (2012) and Gjerdingen (1991) describe as cross-historical learning of schemata. Byros writes, "In so far as eighteenth-century affordances are still available through the conservation of the repertoire, it is conceivable that modern listeners may acquire knowledge structures that are analogous to those of their ancestors from two centuries ago" (Byros 2012, 235). As one example of this, the PD power up identified within the concerto by Seitz, mentioned above, was written in the year 1900, implying that this schema was known at some level to composers beyond the Classical era.

Section 7: Conclusion

[7.1] The pre-dominant function is a widely used concept in North American music theory: a harmonic category touted as important for the affective quality of a phrase—e.g., phrases "include a predominant harmony to heighten the sense of trajectory toward closure" (Peterson 2021)—and one that is referenced beyond the confines of classical style (Snodgrass 2015; Nobile 2016). Yet the pre-dominant function remains underdefined in relation to frequency, repertoire, musical form, and even chord membership. This study is the first systematic exploration of chords preceding V, offering an understanding of chord frequency in relation to formal context and empirical sources for the notion of pre-dominant strength. Our results suggest that in Mozart's sonata-allegro movements for piano, chords designated as pre-dominants in theory textbooks carry predictive information as signals of cadential closure at various formal locations. Chords differ before V depending on whether they are at a cadence, and different cadence types have their own pre-dominant profiles. For example, the cadence ending a main theme is always preceded by a diatonic pre-dominant chord (and never a chromatic one). We contend that such contextual information could be incorporated into music theory pedagogy more explicitly.

[7.2] This study is also the first to explore existing claims made about the pre-dominant function from an empirical basis, and we assert new theories surrounding it, each related to pre-dominant strength:

1. We argue that pre-dominant strength is not based simply on frequency, but is more specifically a function of how often a chord is predictive of a cadence. Indeed, in [3.3] we put forth a way to measure and hierarchize pre-dominant chordal strength and offered evidence that trained musicians have internalized this hierarchy.
2. Moreover, we assert that these stronger pre-dominants are often reserved for particular events, marking them for consciousness. Proposing a "rare pre-dominant hypothesis," we suggest that the theoretical significance of certain chromatic chords before V has more to do with their status as signifiers of form-defining cadences (such as the medial caesura) rather than their overall frequency. That is, we found that although augmented sixth chords are rare in the dataset overall, they are heard most frequently prior to the dominant that occurs in the false retransition (Spitzer 1996)—V of vi within the development—suggesting a more predictable role for this chord than has been discussed in theoretical literature.
3. We elucidate a phenomenon that we call the "pre-dominant power up" where approaches to V are modified between analogous sections of the exposition and recapitulation and illustrate that these changes often involve incorporating a stronger pre-dominant to amplify tonal closure in the movement.

The new insights into the pre-dominant function in this article may be of interest to researchers studying sonata theory, music theory pedagogy, and music cognition.

[7.3] Finally, we emphasize that this study should serve as a proof of concept. It is unsurprising that many findings were consistent with textbook claims, as we selected the Mozart sonata-allegro movements because of their ubiquity in North American undergraduate curricula; indeed, they may very well be the unstated benchmark for the generalized harmonic guidelines in music theory textbooks. Our dataset, while sizeable in some ways, is also limited in scope, and while findings are suggestive for how pre-dominants have traditionally been taught, we caution against broader generalizations about the pre-dominant function, as it may be genre- or composer-specific (Tymoczko 2011; White 2014; Nobile 2016). Yet, we believe that some of the offerings herein not only provide a basis for harmonic guidelines in theory texts but also suggest a methodology for determining pre-dominant strength, examining chord ordering within the function, and studying concepts such as the rare pre-dominant and pre-dominant power up; this methodology can be used to gain a better understanding of the function in other datasets. As music theory instructors look to introduce a greater variety of music into the classroom, guidelines offered about harmonic function must surely not remain static. Thus, our dataset and the trends it contains will be most meaningful in conversation with similarly structured datasets for other repertoires and genres. This, in turn, will help shape a more nuanced, context-sensitive understanding of chordal syntax.

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Author Contribution Statement

This article is the culmination of an eight-year collaboration between JB and DT on this topic. JB and DT jointly conceived of this study and worked together with VB on early hypothesis testing and visualizations; JB and DT contributed equally to writing earlier drafts. JB took the lead on the final manuscript, which was edited by DT. YLL and JB contributed to data analysis. All four authors created examples and provided comments on the final manuscript.

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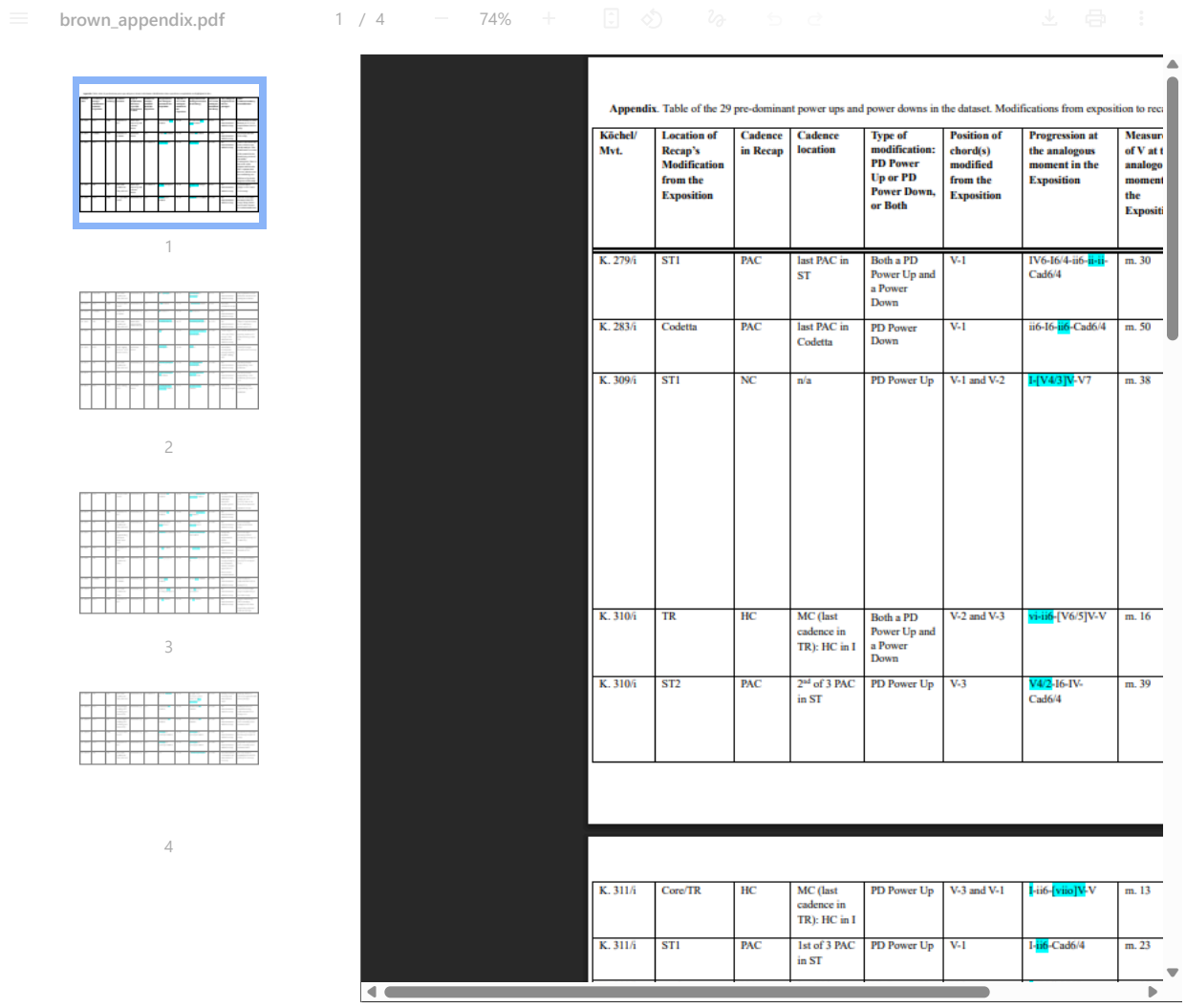
Appendix

Table of the 29 pre-dominant power ups and power downs in the dataset. Modifications from exposition to recapitulation are highlighted in blue.



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Footnotes

1. For a history of the term "pre-dominant," see White and Quinn (2018, 314–16) and Brown, Tan, and Baker (2021, 21–23).
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2. The term "dominant preparation" can be traced to Forte (1962) and Guck (1978). More recently, Caplin writes, "pre-dominant harmonies (sometimes referred to as 'dominant preparation' harmonies or even more generically as 'subdominant' harmonies) include a wide variety of formations whose principal function is to progress to dominant" (2024, 23n72). Nobile (2016) and White and Quinn (2018) adopt similar views on the importance of location in their explorations of harmonic function.
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3. Ewell (2020) provides a list of the seven most popular textbooks in North America, with Clendinning and Marvin (2016) and Kostka, Payne, and Almén (2018) occupying 54% of the market share. We surveyed these two texts and found that Mozart's piano sonatas appear on the greatest number of pages, tied only with the Bach chorales.
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4. Over the past two decades, many scholars have created large datasets for the systematic investigation of chord frequency and chord transitions in various classical and popular music repertoires. Other datasets with expert annotations include the McGill Billboard Project (Burgoyne 2011), Rolling Stone Corpus (de Clercq and Temperley 2011), the TAVERN corpus of theme and variation movements (Devaney et al. 2011), and the Annotated Beethoven Corpus (Moss et al. 2019). Expert annotations have also been employed for the dedicated study of cadences, including those in Mozart piano sonatas (Martin and Pedneault-Deslauriers 2015, only half cadences) and Mozart sonata-allegro expositions (Raz, Chawin, and Rom 2021); Bach chorales (de Clercq 2015); Haydn sonata-form string quartets (Sears 2016); first-movement string quartet expositions by Haydn, Mozart, and Beethoven (Duane 2019a; Duane and Jakubowski 2018); and in common-practice music more broadly (Chiu and Myler 2021). The Annotated Mozart Sonata corpus (Hentschel, Neuwirth, and Rohrmeier 2021) also includes cadence labels, but does not contain additional formal analysis. Scholars have also employed computer-assisted methods to create databases for the purpose of studying harmonic syntax. Using these tools, many have focused upon the Bach chorales (e.g., Quinn and Mavromatis 2011; Rohrmeier and Cross 2008; Tymoczko 2003, 2010). Leveraging the music analysis library music21 (Cuthbert and Ariza 2010), White and Quinn (2016) capture pitch simultaneities ("salami slices") for thousands of MIDI files on classicalarchives.com, which includes the Mozart piano sonatas, to create (and analyze) a large database, called the Yale-Classical Archives Corpus. Notably, few such computer-assisted analyses include information about formal structure.
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5. For instance, within the hundreds of musical examples in Clendinning and Marvin (2021), no work is discussed more frequently than K. 545 (which is tied with Bach's D minor invention); indeed, the first four measures of K. 545/i are the first example in the textbook.
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6. Throughout this article and in our dataset, we use square brackets to denote applied chords (reserving slashes for indicating inversions of chords). This is an encoding relic of our corpus's format, as Excel has limited text formatting options within individual cells.
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7. We analyzed outer movements only and excluded slow movements, as slow movements "differ fundamentally in their proportions and internal organization from fast ones" (Raz, Chawin, and Rom 2021, describing their own dataset; see also Rosen 1988). Twenty of the 22 movements in the dataset were composed in a major mode and just two in minor. We acknowledge that approaches to V may differ slightly in works that vary by mode; future research may explore this possibility further.
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8. An initial exploration of the role of chord length and onset in relation to the pre-dominant function can be found in Tan and Brown 2023.
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9. We acknowledge that the understandings and theories we assert on the pre-dominant in this article are necessarily linked to our initial decision to only consider chords before $V^{(7)}$ and the cadential 6/4 as "dominant," as opposed to also tracking chords before vii^{o}, a harmony also containing the leading tone, for example, but argued to be a "weaker" dominant (Clendinning and Marvin 2021, A-56) and one with "conflicting functional tendencies" (Harrison 1994, 65).
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10. Fewer and fewer non-V harmonies occur as the temporal distance from V increases. Future research could explore the rare instances in which V is preceded by more than three non-V harmonies.
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11. In the dataset, the terms "core" and "pre-core" are borrowed from Caplin but employed in a more general way. That is, we define the "core" as a passage in the development that is

harmonically unstable, features sequential repetition and greater rhythmic activity, and usually has V as the harmonic goal (half cadence or dominant arrival); this can be preceded by a "pre-core" that is "generally more relaxed" and may involve complete or incomplete thematic units (Caplin 1998, 147). We note that Caplin suggests other organizational possibilities for the development section, including "pseudo-core," "transition-like unit," and "subordinate themelike unit" (1998, 155–157). For simplicity, these options were coded as "core" in the dataset; future research could explore approaches to V within these more nuanced categories. A comparison of harmonic activity in cores and pre-cores is outside the scope of this article.
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12. Additionally, an "elided PAC" was used to identify a PAC that coincided simultaneously with the beginning of a new formal unit.
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13. Martin and Pedneault-Deslauriers identify a half cadence in K. 570/i, m. 22, whereas we treated V as part of a brief motion to vi (i.e., NC).
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14. The distinction between modulation and tonicization can also be debated. In our dataset, a modulation to a new local tonic required a cadence. As an example, the passage CM–DM^6–GM would be analyzed as a tonicized half cadence in C major (Clendinning and Marvin 2021, 402–3) rather than as a modulation to V (G), given that the D major chord is not in root position (Caplin 1998).
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15. We acknowledge that there is some nuance lost by using chord categories that collapse inversions in Examples 3 and 5. Some initial observations can be provided here. Before collapsing all applied dominants of V into the category "Applied dominant of V," for example, we noted that $[V^6_5]$V leads most to a cadence, followed by $[V^4_3]$V then $[V^7]$V. Further, the applied dominant always carries a chordal seventh when leading to a cadence. As has been noted earlier, the supertonic leads to a cadence when in first inversion far more than in any other inversion, and both root position and first inversion applied leading-tone chords are the common inversions that move frequently to a cadence.
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16. Spearman's rank correlations were employed instead of Pearson's, as frequency data were observed to be not normal using a Shapiro-Wilk test. These correlations have been used in other studies to compare corpus statistics with behavioral response data (e.g., Schwitzgebel and White 2021).
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17. We observe similar findings when comparing attraction ratings of the 31 chords with how often they appear as V-1 in the entire dataset (not just at a cadence): for junior/senior music majors, the correlation is $\varrho = .586$ ($p < .001$), and for the Prolific participants, the correlation is $\varrho = .309$ ($p < .091$).
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18. We use the term "applied of V" chords to encompass all $V^{(7)}$/V and $vii^{o(7)}$/V chords and their inversions.
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19. Kamien and Wagner (1997) argue that the overall motion in an exposition from the tonic key to a chromatic pre-dominant (e.g., $[vii^{o7}]$V or augmented sixth) to V in the new key of V is born out of a chromatic voice exchange (cf. page 3 of their article). While they do not share any examples from the piano sonatas, the analysis of our dataset supports their description of this long-range syntax in the expositions of four of Mozart's other works: "An applied chord, such as an applied diminished-seventh chord, often leads into the [dominant in the new key] at the end of the bridge" (1997, 1).
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20. We conducted a binomial test to determine whether the frequency of chromatic chords (applied of V and augmented sixth) is disproportionately higher at the end of TR sections. Before all endings of MT, TR, and ST, applied of V and augmented sixth chords occur 53 times out of the 163 cadences ending in these sections (making up 32.52% of V-1 at these cadences). At specifically TR, however, these chords occur in V-1 32 times out of 43 TR cadences (now 74.42%); this is significantly more than expected ($p < .001$).
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21. Whereas Example 7 shared V-1 chords prior to the end of all MTs and STs within the dataset (e.g., ST1, ST2, ST3), Example 9 tabulates only V-1 chords at final cadences of the last MT and ST within MT and ST groups. Thus, if a movement contains ST1 and ST2, the cadences ending ST1 and ST2 are included in Examples 7 and 8, but only the cadence ending ST2 is included in Example 9.
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22. Ivanovitch (2011) illustrates various types of retransitions in Mozart's developments; we speculate that there may be a connection between retransition types and common pre-dominant harmonies preceding the D arrival.
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23. A brief primer on reading the heatmap: Chord successions that happen often are in red, followed by successions that happen less often are in pink then yellow. Chord successions that never occur are shown in green. The row and column headers represent chord roots, encompassing all inversions of triads and seventh chords, and unless otherwise stated, both major and minor modes. If we want to know how often the submediant goes to the supertonic, for example, we first find submediant within the leftmost column under "V-2" and then scroll right to find "supertonic" on the top row, revealing that submediant→supertonic occurs before V 34 times out of the total 1129 dominants in the dataset.
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24. The heatmap collapses all inversions. Future research might take inversion into account; for instance, not captured in this heatmap is that tonic in root position (V-2) moves to tonic in first inversion (V-1) 23 of these 47 occurrences.
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25. The finding that frequencies of chords differ at cadences was statistically significant. Using a binomial test, we found that the tonic→supertonic progression is indeed significantly more frequent at cadences, occurring 93 times out of the 374 cadential progressions (24.87%), but only 121 times out of the 1129 total dominants (10.72%), $p < .001$.
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26. For this calculation, we counted these chords in V-2 to V-1 and also V-3 to V-1 if V-2 was a passing 6/4.
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27. Movements reaching V of vi in the development within our dataset are K. 279/iii, K. 280/i, K. 280/iii, K. 281/i, K. 282/iii, K. 283/iii, K. 309/i, K. 311/i, K. 332/i, K. 333/i, K. 533/i, K. 570/i, and K. 576/i. Of these, the only movements without an augmented sixth before the V of vi are K. 281/i, K. 282/iii, and K. 309/i.
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28. Beach (1983) also lists developments containing III♯ in the piano sonatas and describes the voice-leading in more detail (his fn1). Unlike Beach, we also include K. 281/i in our count because it reaches V of vi in the development (via an IAC and PAC in the key of vi). Note that while Beach (1983) and Burnham (2012) refer to motion to V of vi in the development of K. 310/ii that is preceded by an augmented sixth, this movement is not included in our counts because it is a slow movement and not included in our dataset. Duane (2019b) offers a comprehensive study of development sections in a corpus of music by Haydn, Mozart, and early Beethoven, finding that motions to vi occurs over two-thirds of the time within developments in works composed in the

1760s and 1770s but becomes less and less frequent afterwards. Hepokoski and Darcy, too, discuss the frequent use of a dominant arrival in vi within classical developments (2006, 198–201). Similarly, Spitzer (1996) describes V of vi in retransitions in the music of Haydn, noting its resurgence in the 1770s as a way to heighten the rhetorical narrative of the retransition. We note that while developments containing motion to V of vi have been described by many theorists, including the authors above and also Burnham (2012, 131), Caplin (1998, 141), and Rosen (1988, cf. 263), the consistent connection of the augmented sixth to catalyze this harmonic arrival is not addressed in these writings.
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29. For example, Laitz states that "the Ger6/5 [...] should move first to a cadential 6/4 in order to offset the parallel fifths that would occur with a direct move to V" (2008, 681). Similarly, Clendinning and Marvin write, "the Gr^{+6} usually resolves to an embellished V6/4-5/3 rather than directly to V" (2021, 586). These data also contradict Caplin's claim that "The German augmented sixth creates parallel fifths when resolving to a dominant triad, so this 'nationality' is used less frequently in HCs than in ACs, where it typically resolves at first to a cadential six-four" (2024, 104n153).
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30. While Caplin (1998, 163 and 165) discusses the frequent use of flat scale degrees in recapitulatory main themes and transitions ("regions that introduce chromatically lowered scale-degrees, such as the subdominant, the lowered mediant, the lowered submediant, and the Neapolitan," p. 163), our data suggest that this is also a frequent modification to subordinate themes.
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31. Lahdelma and Eerola (2016a, 2016b) found that participants perceived an increase in energy and tension from root position chords through first inversion to second inversion. For this reason, we also treated chords in subsequent inversions (e.g., root to 6/5, 4/3 to 4/2) as PD power ups.
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32. We thank an anonymous reviewer for pointing this out in Example 18.
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33. Of the 25 novel passages unique to recapitulations, 19 occur in the ST (and two in MT1, two in TR, and two in Codettas). In these excerpts, chromatic pre-dominant chords seem to occupy a disproportionally high number of approaches as the chord directly prior to V (10/25 = 40%). An example of a novel section occurs in Mozart's K. 279/i, recapitulation. When comparing the cadence ending the TR in the exposition at m. 16, V is approached by V^6_4–I^6–ii^6. In contrast, the V ending the recapitulatory TR in m. 67 is approached by V^6_5–I–[vii^{o7}]V. While these are similar cadences (both terminal Vs ending TR), we consider the harmonic-melodic content to be novel enough in the recapitulation to be treated differently than power ups and downs. This type of novel passage could be the focus of future analytical inquiry.
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34. Byros's work (incorporating the theories of Narmour and Meyer) is influential in this argument. He writes: "Expectation, as suggested above, is an indication of a schema-based process: 'Knowledge of style enables listeners to recognize similarity between percept ['sound stimulus', in Meyer's terms (1956)] and memory[,] and thus to map learned, top-down expectations ... . Listeners [therefore] construct stylistic expectations that are remarkably specific, surprisingly complex, and incredibly detailed' (Narmour 1999, p. 441). Meyer anticipated this argument in *Emotion and Meaning in Music*, by proposing that we form expectations because we organise new musical experiences according to past experience: 'we organize our experience and hence our expectations ... in terms of our memories of earlier relevant musical experiences' (Meyer 1956, p. 88). Expectation results from the activation of a schema as an evaluative recognition device" (Byros 2012, 310).
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