Polyphony, Uncertainty, and Exploration in Sonata Form: Commentary on De Souza, Dvorsky, and Oyon

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ABSTRACT: The following is a commentary on De Souza, Dvorsky, and Oyon's (2024) target article on polyphonic texture and sonata form. Their study suggests that development sections display more polyphony than exposition sections, as indicated by lower onset synchrony. However, the expected increase in polyphony during transitions was not observed. Using the exploration-exploitation framework from cognitive science, I propose potential explanations for these findings. I also recommend that future research on polyphonic texture incorporates expert evaluations alongside computational metrics to achieve a more nuanced and comprehensive understanding of musical texture.

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IN their study, De Souza et al. (2024) conduct a comprehensive corpus analysis examining the relationship between musical texture and large-scale form in classical string quartets by Joseph Haydn, Wolfgang Amadeus Mozart, and Ludwig van Beethoven. They report that development sections have significantly lower onset synchrony compared to exposition sections, suggesting higher polyphony in developments. However, the results do not support their hypothesis that transitions within expositions would be more polyphonic than other subsections; transitions did not show lower onset synchrony.

This insightful research advances our understanding of sonata form and opens new avenues for both theoretical exploration and empirical validation. The following sections delve into possible explanations for the unexpected findings regarding transitions and propose methodological enhancements for future research.

COMPARING TRANSITIONS WITH DEVELOPMENT SECTIONS

The discrepancy between the expected and observed polyphonic texture in transitions warrants further exploration. One potential explanation lies in the transition's function: a passage designed to generate an "energy-gain" to propel the music toward its next structural goal, often marked by a medial caesura (Hepokoski & Darcy, 2006, pp. 93–94). The transition may not need to employ a highly polyphonic texture to achieve this goal. Conversely, the development section, which often sustains tension over a longer duration, may rely more on polyphony to heighten the desire for the return of the (most often) homophonic primary theme.

To better understand these distinctions, it is helpful to consider the exploration-exploitation framework from cognitive science. This framework explains how individuals balance exploring novel possibilities (exploration) with leveraging familiar information (exploitation) to achieve their goals (Berger-Tal, Nathan, Meron, & Saltz, 2014; Hills et al., 2015). For example, a music enthusiast on a streaming platform might exploit their schematic knowledge of familiar genres to understand and emotionally connect with familiar music, thus gaining abstract rewards like joy or emotional resonance. Alternatively, they might explore unfamiliar music, and while initially less skilled at interpreting it, they may derive abstract rewards through unexpected pleasure or the acquisition of new knowledge. This exploration-exploitation dynamic applies not only to listeners but also to composers, who can embed cues in their compositions to guide and influence their audience's listening experience. For example, by maintaining a steady groove, a composer encourages the listener to exploit the regular rhythm. On the other hand, by introducing a meter change at the

start of a new section, the composer signals a shift toward exploration, prompting the listener to engage with the unfamiliar elements of the piece.

Listening to music may enhance the ability to flexibly switch between exploration and exploitation, an essential skill for adaptive behavior in uncertain situations. In sonata form, composers distribute varying degrees of tonal tension and novelty throughout the piece, prompting listeners to engage in exploration or exploitation as musical uncertainty and emotions fluctuate. After the exposition of the first theme, transitions typically exploit existing material while also exploring new tonal areas. The arrival of the second theme represents further exploration of musical ideas. As a passage that builds anticipation, the transition not only prepares the listener for the next theme but also generates excitement and motivates engagement. Neuroscientific research suggests that exploration is facilitated by neurotransmitters such as norepinephrine and dopamine (Wilson, Bonawitz, Costa, & Ebitz, 2021), which are linked to increased arousal and motivation. This suggests that the listener's exploration of the second theme may be enhanced by the preceding "energy-gain" generated during the transition.

In contrast, the development section often employs more extensive polyphony to sustain engagement over longer periods. Particularly before the retransition, it heightens tension through elements like conflict, instability, dissonance, and uncertainty, fostering a strong desire for resolution (Lehne & Koelsch, 2015; Tsai, 2023). While it exploits materials from the exposition, the development also allows for exploration by transforming and varying these themes. This controlled uncertainty enables complex musical exploration without devolving into unpredictability (Tsai, 2024). Notably, polyphonic textures, which lead to the perception of separate voice parts and make it harder to focus on a single line (Ishida & Nittono, 2024), amplify cognitive tension in the development section. The interplay of voices can blur the listener's focus, creating uncertainty about which voice to follow. Consequently, polyphonic textures in the development section may heighten the listener's yearning for the return of the more homophonic primary theme.

Thus, although both transitions and development sections aim to build anticipation for upcoming themes, they differ significantly in how they handle tension and explore musical ideas. Transitions, typically brief, focus on building energy and motivating the listener to explore the second theme. The development section, on the other hand, tends to sustain tension and uncertainty for a longer duration through intricate polyphony. When the primary theme and home key finally return at the start of the recapitulation, the resolution of harmony, thematic material, and texture is particularly satisfying, marking the end of the exploratory phase and the beginning of an exploitation phase. This functional difference may account for De Souza et al.'s (2024) findings that the polyphonic "destabilization," though so typical of development sections, does not extend to transitions.

INVESTIGATING POLYPHONIC TEXTURE

While onset synchrony is a valuable quantitative measure for assessing aspects of polyphonic texture, relying solely on this metric does not fully capture the complexity of musical textures. Onset synchrony quantifies the alignment of note onsets across voices, but polyphonic texture encompasses many more dimensions. I recommend that future research incorporates additional quantitative measures alongside onset synchrony. For instance, linear regression can be applied to model pitch motion, with the slope of the regression line representing the rate of pitch change. By comparing these slopes across different voices, it is possible to assess the directionality of pitch motion. Similar slopes would indicate aligned pitch movements, typically corresponding to parallel motion, whereas significant differences in slope values may reflect contrary motion or the use of other contrapuntal techniques.

Moreover, integrating expert evaluations into the analysis could enhance the validity of the findings. A mixed-methods approach, combining computational metrics with assessments by music theory experts, would offer a more nuanced understanding of texture. Experts could evaluate representative musical passages based on criteria such as:

1. Temporal Coordination: Experts could assess the degree of rhythmic coordination between voices.
2. Voice Independence: Experts could evaluate whether each voice maintains clear independence. Are the melodies in different voices distinct and interactive, with each voice possessing its own motives and rhythmic patterns?
3. Pitch Motion: This criterion would assess the presence of significant contrasts or imitations between the pitch movements of different voices, including contrary or parallel motion.

4. Contrapuntal Techniques: Evaluating the use of contrapuntal techniques, such as imitation or canon, and judging their prevalence and significance within the texture.

While expert evaluations offer valuable insights, they do come with challenges. Expert evaluations can vary between individuals, potentially introducing inconsistencies. Additionally, coordinating expert assessments can be time-consuming and resource-intensive. However, expert input can refine computational models, making them more sensitive to musical nuances and complexities.

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NOTES

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