Using music to probe how perception shapes imagination

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Abstract

Recent work using music highlights how past experiences and the immediate perceptual environment can shape imagination. Because aspects of past experiences can be shared, depending on culture, as can the immediate perceptual environment, imaginings that might seem idiosyncratic or entirely subjective can actually be broadly shared.

The spontaneous imaginings people sustain in their daily lives—thoughts or imagery in any modality that are not a direct result of current perception—have ordinarily been studied as episodes of mind wandering or stimulus-independent thought [1]. Sometimes, imagining can be goal-directed, such as when a person creatively generates ideas to solve a problem; in these cases, perceptual cues play a clearer stimulating role. Even more broadly, the scope of what's imaginable is grounded by our previous perceptual interactions with the world. But recently, it has become increasingly clear that even in non-goal-directed contexts, the content of spontaneous imaginings can be profoundly shaped by the immediate perceptual environment. For example, the social content of spontaneous thoughts can reflect a person's immediately preceding and concurrent social context [2].

One important consequence of emphasizing that spontaneous imaginings are grounded in present perceptual experience and shaped by the environment, is that insofar as perceptual experiences are shared among individuals, imaginings that might initially seem to be idiosyncratic and highly subjective should in fact reveal surprising similarities. Indeed, research has uncovered the way even memories themselves, which would seem to be unique to individuals, can entail representations that are broadly shared. For example, pattern similarity analysis reveals shared neural representations across individuals during both memory encoding and retrieval [3]. Additionally, the temporal progression of neural response patterns to naturalistic stimuli is more similar between individuals as a function of their proximity within a social network, suggesting that shared experiences breed even more shared representations [4].

Music listening is emerging as an ideal domain for studying spontaneous imaginings and the extent to which they can be shared between individuals. While listening to music, people's focus

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frequently shifts from the sound to imagined scenarios, ranging from autobiographical memories to fictional scenes. Notably, autobiographical memories evoked by music are often powerful, involving greater episodic reliving, more personal significance, and more positive, intense emotions than autobiographical memories evoked by other stimuli [5]. In this regard, visual imagery has been cited as one of the most important drivers of emotional response to music. The more vividly a person imagines visual imagery while listening to music, the higher they rate that music's aesthetic appeal [6]. Since highly engrossing and pleasurable imaginings of various modalities, from visual to kinesthetic to conceptual, often emerge during music listening, it is fertile ground for exploring the relationship between environment and imagination.

Pursuing this aim, a series of recent articles have looked specifically at the narratives people imagine while listening to excerpts of previously unfamiliar instrumental music. Individuals, regardless of culture, readily imagine stories in response to music, both for musical traditions that are familiar and unfamiliar to them [7]. Imagined stories generated to music provide an interesting testing ground for the relationship between perception and imagination, because a story involves the temporal succession of events, just as music unfolds dynamically, providing an opportunity to study how a stimulus that is changing in real time shapes the dynamic time course of an imagined episode.

Despite that participants are given a highly unconstrained task—providing a free-response description of any story they imagine while listening to a musical excerpt—story content exhibits striking within-culture similarities, with individuals frequently using the same words ("tiny creatures frolicking" or "man strolling around the city streets in the 1920s") to describe their imaginings to individual excerpts [8]. This was true even though participants were tested one at a

time at distinct geographic locations (Arkansas and Michigan), making it highly improbable that individual responses were affected by other participants' reports. Instead, musical excerpts seemed to spontaneously cue similar imagined stories in listeners.

This intersubjectivity breaks down, however, when participants do not share an underlying culture, broadly defined. Participants in Dimen, a Dong village in a rural part of China, readily imagine stories in response to the same musical excerpts, but they imagine different stories than US participants. One question that arises is even if people do not spontaneously generate the same narrative across cultural lines, perhaps they would at least recognize which stories are plausible matches for individual excerpts. To consider this possibility, participants were given a story-matching task. Although people could correctly match stories to the corresponding musical excerpt when the stories had been produced by participants within the same culture, they had much more difficulty when tasked with matching stories generated across cultures [9].

The implication is that distinct stimuli—in this case, musical excerpts—shape imaginings such that when participants share a sufficiently similar pool of previous experiences, they freely imagine broadly similar things to new input. Since any novel generation partly involves the reassembly of preexisting parts, shared memories might scaffold the creation of shared new imaginings. As a further test of the hypothesis that stimuli characteristics drive shared imaginings, participants were asked to listen to musical excerpts and click a mouse at the moments when they imagined a new event in their dynamically unfolding imagined story. For individual musical excerpts, people, to varying degrees, tend to click at similar time points, demonstrating that the temporally unfolding characteristics of the music shape imagined narrative in real time [10]. Figure 1 illustrates how imagined narratives unfold in a way that is time-locked to changes in the music.
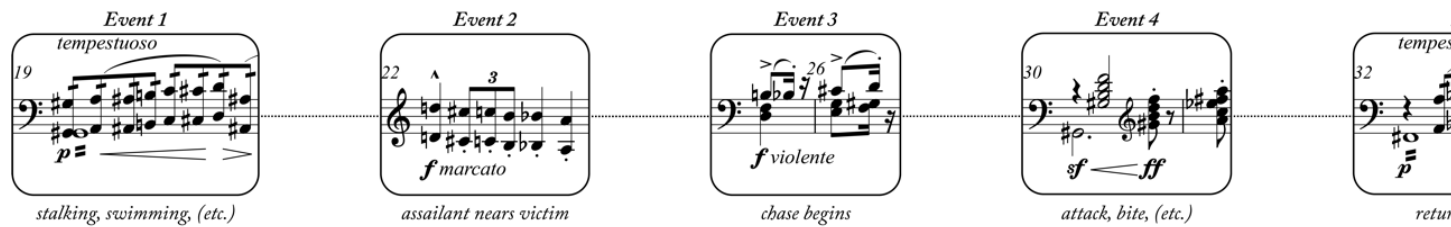
Figure 1. Mappings between Imagined Story Events and Musical Features. When people imagined stories while listening to instrumental music, they tended to imagine new events in their ongoing imagined story at timepoints linked to musical features, such as the entrance of a new theme. This figure depicts a representative example of how events in one participant's imagined story map onto particular events in the music, drawn here from Liszt's Dante Symphony. When musical events repeat (as in Event 1 and 5), the corresponding story events are also imagined to recur. Reproduced with permission from *Music Theory Online*.

Using music to probe the contents of imagined episodes reveals a dimension of intersubjectivity that extends among individuals with shared past experiences (i.e. shared culture, or shared memories). New tools in natural language processing permit the analysis of these patterns of distributed subjectivity, whereby multiple individuals sustain highly similar imagined narratives in response to individual excerpts of unfamiliar music. The task used in these studies is naturalistic and highly unconstrained; people generate free response descriptions of the fictional scenes they imagine while listening to instrumental music. Yet advances in machine learning make it feasible to study the structural regularities that emerge in these descriptions, revealing that musical stimuli can shape the contents of the imagination dynamically in real time in ways that are robustly shared across individuals.

These discoveries sit at the intersection of numerous lines of inquiry and have broad implications. Given that guided imaginings to music are integral to music therapy [11], understanding the relationship between musical features and imagined responses can help develop better therapeutic interventions that are sensitive to culture. More broadly, the reviewed research highlights that because imaginings are shaped by environmental stimuli and past experiences that can be shared within a culture, even subjective imaginings can be characterized by striking similarities among individuals. These similarities in imagined content follow the contours of cultural boundaries; only if people have had sufficiently similar previous experiences do their imaginings align in this way. Future research should investigate the relationship between perception and imagination for environmental cues that extend beyond the model domain of music. The boundaries between imaginative content that is shared versus distinct could reveal much about the degree to which culture drives thought, and about the constituent components of creative processes.

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