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Timbre Blending in a Continuum and its Implications for Everyday Life

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Mixing or blending the timbre of sounds, especially musical sounds, is an important technique in many fields. Composers, sound designers, and perception researchers in psychology make use of such blends for a variety of purposes. For instance, composers have a long-standing history of creating timbre blending effects through sophisticated orchestration, and have also theorized about creating hierarchies of timbre that would be useful in delineating large-scale form and structure in music [1]. Indeed, some composers, such as Xenakis, have put these theories into practice, creating novel pieces that use timbre at a structural level. Contemporary composers on the cutting edge of technology have used analysis/resynthesis software to create surprisingly realistic effects where one sound seamlessly transforms into another [2]. The ability to blend the timbre of sounds is also useful for many applications in practical arenas, including film production and even national security. Psychologists have tried to illustrate the validity of different perceptual dimensions of timbre by using hybrid timbres in multidimensional scaling experiments [3,4]. Further, more recent research on how people actually react to these timbre blends has shown that listeners are able to track subtle changes in timbre along a continuum from one sound to another rather than assimilating them into distinct categories as is usually observed in the processing of linguistic sounds when, say, a "b" is gradually transformed into a "p" [5].

There are different approaches to timbre blending. The process of creating a fixed hybrid timbre often involves subjective sound design choices using basic synthesis techniques until the desired result is found (e.g., Krumhansl's "guitarnet"). But this does not always yield a method for parameterizing the amount of timbre blending between the two source sounds. Another set of approaches involve using analysis data to graft the spectral characteristics of one sound onto that of another [3]. Techniques in the latter category enable the creation of a timbre scale or continuum between two known sounds, which we see as especially important. For instance, compositionally, timbre continua provide a musical parameter for creating tension and expectation. To be sure, composers have regularly used this parameter long before computers became an integral part of music making (e.g., changing gradually to sul ponticello bowing on a cello). But computers offer a new degree of control and breadth to enrich the compositional possibilities. Indeed, with a well-developed theory and technique for creating perceptually gradual (but still discriminable) changes between arbitrary pairs of sounds, the concept of timbre can expand much further as an organizational structure in musical composition.

As a process, timbre blending along a continuum is far from straightforward. This is due to the widely acknowledged multidimensional nature of timbre as an aspect of sound. Physical correlates to the primary perceptual dimensions of timbre that have been identified include spectral envelope, high frequency energy patterns during the sound onset, and spectral flux [6]. Blending can therefore be achieved by artificially altering any or all of these parameters, but the right balance and degree of these alterations must be found for each specific combination of sounds being blended. For some, the most satisfying blend may be found by altering spectral envelope, for others special attention must be paid to the onset, while for others it may be that no approach yields a satisfying result. Currently, there are no theoretical guidelines to turn to when attempting to blend the timbre of two arbitrary sounds. Most blending to date has been achieved through the use of individual algorithms that "work" between any two timbres according to the creator's ears. In fact, a different algorithm may be needed for each separate blend. Once achieved, any theoretical model of timbre in blending guidelines could then have implications in extending similar research to encompass not only musical tones but environmental sounds and human voices as well.

The ability to alter a large variety of sound parameters with great precision is critical to applications in *auditory display*. The field of auditory display involves techniques for using non-speech sound to transmit information from a computer to a human being, and is useful in any situation where visual display is not practical (e.g., while driving). This is especially relevant to the vision impaired. Because aspects of sound that can be varied in a continuous fashion for these purposes are relatively limited (e.g., pitch, loudness, tempo), there is a need for novel sound parameter continua. Timbre, because of its complexity, would be an ideal dimension for generating a variety of new auditory display information channels. In fact, creating continua between different timbres would not only aid in the richness of auditory display as a medium for communication, but would also have implications in improving the ability to segregate sounds in the everyday world of complex sound scenes with simultaneous auditory inputs.

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