Crescendo: Haptic Exploration of Scores for Novice Musicians with Dyslexia

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Abstract— **Music students with dyslexia often struggle with rhythm, matching pitch, and reading musical notation, problems that can continue as they develop expertise. In pedagogy, it is common to use multiple modalities to teach students with dyslexia to read musical notation. This paper introduces an augmented, multimodal score for novice music students with dyslexia called *Crescendo*. The program uses a computer running Processing and a pantograph-type device. The augmented score reinforces pitch and duration haptically and aurally as the user freely explores the score. Initial evaluation of the system with non-dyslexic users indicates it would likely be accepted by novices.**

I. Introduction

Dyslexia is a common learning disability that affects approximately 7% of the population [1]. As the impacts of dyslexia are not strictly limited to reading written language, some dyslexic individuals experience difficulties in music. Research has shown that adults with dyslexia perform worse on tasks evaluating the recognition of pitch and rhythm [2]. Some researchers have suggested that the use of multisensory music notation, in addition to appropriately adjusted teaching techniques, may aid students with dyslexia in learning music and specifically music notation in the classroom [3], [4].

In this paper we introduce *Crescendo*, a multimodal music software that complements a musical score with auditory and haptic feedback to aid students with dyslexia in learning to read music notation. The following sections summarize the current prototype and preliminary feedback received from non-dyslexic users.

II. Multimodal Music Notation

The current prototype of *Crescendo* (Figure 1) focuses on reinforcing note pitch and duration. Audio and haptic interactions occur as the user moves the end effector through measures of a score, using the end effector like one would use a pen to follow along while reading music. As the end effector passes over notes, notes are synthesized and played for the notated pitch and duration. A Haply 2diy[1] (Haply
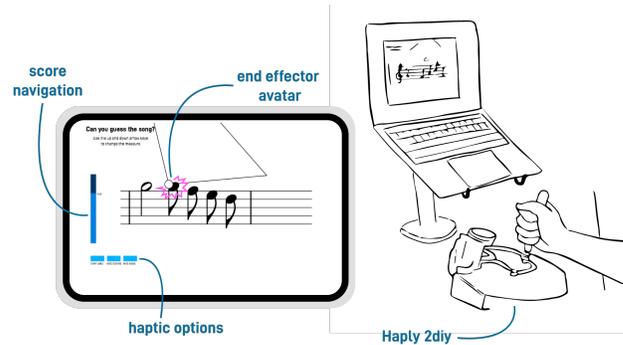

Fig. 1. Interface of the multimodal music software *Crescendo*. Haptic effects are delivered as the avatar passes through notes and staff lines.

Robotics), a low-cost 2 degree-of-freedom force feedback pantograph, is used to kinesthetically display the locations of staff and ledger lines and the locations of notes. Forces on lines are expressed as a Gaussian curve, resulting in a "bump" when passing over them. Notes are given a sand-like texture for recognizability. Nudging forces are rendered on notes, moving the user slightly towards the next musical element, to aid in following the musical contour.

III. Preliminary User Feedback

We evaluated the performance of the interface by conducting a pilot experiment (n=3) with participants without dyslexia to determine if the complementary multimodal effects were useful orienting tools. We tested if participants could identify the location of the end effector within the score without visual feedback. The on-screen representation of the end effector in the score was hidden, leaving only audio and haptic feedback. Participants were then asked to explore the score and correctly identify the note they were on, a task they completed successfully. This suggests that multimodal feedback of this type can augment understanding of the score. Further experiments are necessary to determine the contributions of the different channels of the system and *Crescendo*'s performance with users with dyslexia.

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