I Play for Togetherness: Impacts of Audio-Visual Asynchrony on Feelings of Social Closeness in Adult Community Wind Band Musicians

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Abstract

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The purpose of this dissertation is to explore the effects of audio-visual asynchrony on feelings of social closeness in adult community band musicians. This study is situated within the fields of music cognition and sociology and explores how changes to the cognitive load of a performing musician by means of conflicting sensory information affects interpersonal relationships, feelings of belonging and group solidarity, and feelings of social closeness. Adult instrumental musicians (N = 163) from four groups within the Cosmopolitan Music Society (Edmonton, Alberta, Canada), participated in this study which utilized a pre-test/post-test experimental design. Both quantitative and qualitative analyses, including the composite measure called the Social Closeness Index (SCI), indicated audio-visual asynchrony negatively impacted feelings of social closeness. Group membership was a significant factor in changes in feelings of social closeness, with novice, intermediate, and advanced groups experiencing large drops in SCI scores, and the beginner group experiencing very little effect. Implications and suggestions for further research are discussed.

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Acknowledgement

Thank you to my professors and graduate cohort for your collegial interactions, stimulating conversations, and support throughout this scholarly journey. I have grown in ways I could not have imagined as a result and am inspired to ask deeper questions and seek new and diverse perspectives of understanding.

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Dedication

To my parents, Rose and Arnold: who instilled the love and value of education and lifelong learning, and who supported me in every way through my life thus far and this degree. I thank you with all my being.

To my husband, Troy: who believed in me, encouraged me, held the fort while I was away, took care of Misty, and provided for me when I couldn't. My gratitude and love for you know no end.

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CHAPTER 1: Introduction

The study described in this dissertation was inspired by my experiences with group music-making, particularly in the wind band context, as well as my exploration into the cognitive aspects of music-making. As a music educator and community music leader, I'm often faced with the question of "why does music matter" (sadly, generally in reference to defending funding), and I consistently respond that music makes us feel good, makes us feel like we belong to something greater than ourselves, and provides a space of respite from the daily grind of our regular lives. These statements are based on anecdotal evidence collected over the years of teaching music in various contexts, from elementary and junior high music classes in the public-school setting, to college and adult community band. From the scientific perspective, however, I want to understand the why and how music influences our brains and our behaviours from a position of robust research.

Interpersonal relationships are cornerstones in human society. The values of such relationships are determined by personal experience, and social groups who tend to have similar experiences will tend to have similar values and seek out similar relationships (Small, 1998). Musical ensemble performance in particular is a universal means of non-verbal communication that is achieved through specialized and codified forms of social interaction (D'Ausilio, Novembre, Fadiga, & Keller, 2015). It is seen as a special type of human behavior that involves multiple individuals coordinating thoughts and movements in space and time with the goal of communication (Keller, Novembre, & Hove, 2014). One key component of ensemble music making is summed up by Small (1998): "the act of making music with others is to experience those relationships and arouse a powerful emotional response" (p. 137). Equally, a second key

component of the social and emotional power of music is that it further tightens interpersonal bonds (Stupacher, Maes, Wood, & Witte, 2017).

This dissertation explores the social outcomes of individual responses to the cognitive demands of the large ensemble environment. The study contained within is designed to explore the intersection of sensory cognition and interpersonal relationships through the introduction of audio-visual (sensory) asynchrony. The review of literature includes perspectives pertaining to the cognitive load of the large conducted music ensemble, as well as the interpersonal and sociological perspectives of ritualized activity, shared goals, and group membership. A thorough examination of these complementary perspectives lays the foundation for the study method and frames the obtained results. The final section of this dissertation is a discussion of the results in the context of extant literature and suggests directions for future research and exploration of the cognitive and social aspects of large ensemble performance.

Cognitive Perspectives. The environment of large ensemble music making is a highly complex and dynamic system. In a performance or rehearsal players have to concurrently navigate sensory information from multiple stimuli. Group music making combines aural information (sound), visual information (conductor, movements of other players, reading music), and kinesthetic information (motor functions necessary to move fingers, hold instruments, breathe, articulate, and make the instrument work in accordance with the needs of the music), to actively coordinate the self with the other members of the ensemble. Successful coordination requires a nuanced and robust cognitive system of self and interpersonal awareness.

Overy and Molnar-Szkacs (2009) stated music is an engaging, multisensory social activity. Group music-making involves the synchronization of physical actions with extraordinary temporal accuracy and flexibility. The context of shared knowledge and common

goals seems to be a foundational component to synchronous movement in ensemble musicians (Keller, Novembre, & Hove, 2014). Shared goals ensure ensemble musicians take into account the actions of their co-performers and employ regulatory strategies that improve coordination and facilitate ensemble cohesion. Through this intentionality of movement humans activate the complex neural networks that are key systems for interpersonal awareness.

Keller and colleagues (2014) suggest neurophysiological mechanisms that contribute to interpersonal coordination and perception include connections between the motor cortical regions and temporal regions of the brain and those of the auditory cortex. Adaptive timing, the ability to attend to and respond to the movements of others, involves the modulation of neural oscillations in these networks. The resulting cognitive-motor skills of mutual temporal adaptation, attention, and anticipation are then employed to maintain synchronous movement (p.2). These processes have been linked to the activation of structures in the brain associated with socio-affective behavior and indicate a neurophysiological basis for how synchronous movement promotes social cohesion (p. 7).

In research on the effects of synchronous movement on interpersonal behaviors, people who moved in synchrony with others—whether it be in dance, tapping tasks, or musical performance of some type—experienced and demonstrated more positive prosocial behaviors and feelings of empathy than those who did not (Wiltermuth & Heath, 2009, Stupacher, Wood, & Witte, 2017; Carlson, Berger, & Toivianien, 2019). Prosocial behaviors include empathy, cooperation, acts of service, and actively contributing toward the collective good even at some cost or personal sacrifice (see Valdesolo, Oyang, & DeStando, 2010; Wiltermuth & Heath, 2009; Rabinowitch & Knafo-Noam, 2015; Tarr, Launay, & Dunbar, 2016; Tarr, Slater, & Cohen, 2018). The findings of Tarr and colleagues (2016) indicate the physical act of aligning one's

movement with that of others strengthens interpersonal connections, while moving in contradiction to others does not strengthen the sense of affiliation or empathy. Tarr, and colleagues (2018) further suggest that it is the violation of tacit expectations of coordination experienced in non-synchronous conditions that negatively affect prosocial outcomes and feelings of togetherness.

Sociological Perspectives. In 1918, a group of American educational leaders, backed by the US Government Department of the Interior and Bureau of Education, created the Commission on the Reorganization of Secondary Education based on perceived deficiencies of high school students in post-World War I America. At the conclusion of this commission, the committee submitted their report under the title, "Cardinal Principles of Secondary Education." One component of this set of edicts was identified as *Worthy Use of Leisure*. The idea behind this principle is that education should give the high school student the skills to enrich his/her body, mind, spirit, and personality in his/her leisure and that the school should also provide appropriate recreation. The Commission stated this principle should be taught in all subjects but primarily in music, art, literature, drama, social issues, and science (The Cardinal Principles of Education, 1918). Music education has been interpreting this principle in multiple ways ever since, particularly as group music-making is not restricted to schools and institutions; this concept of "worthy use of leisure" extends into adult life and community participation.

According to sociologist Robert Stebbins, leisure is "uncoerced, contextually framed activity engaged in during free time, which people want to do and, using their abilities and resources, actually do in either a satisfying or a fulfilling way (or both)" (2012, p. 4). Leisure embodies commitments of time that range from casual, fleeting participation to intensive short-term projects to more serious lifetime commitments (Stebbins, 2007). In many cases, adult

participation in community music making is taken seriously, with members making purposeful decisions about regular attendance, personal practice, and emotional engagement (Stebbins, 1992). With the serious lifetime commitments, serious leisure pursuits generally encompass more time, money, and energy from the participant.

The effects of collective participation in an activity on an individual have been the basis of study by many sociologists of the twentieth century. Scholars such as Elias (1994/2000), Dunning (1986), and Freud (1961) suggested the heightened emotion and excitement drawn from periodic release found in leisure activities are stark contrasts to the emotional repression and "habit of restraint" (Dunning, 1986) found in being part of a civilized culture. Emotions, therefore, are not a source of bonding but rather a source of personal and social instability. Viewed through this lens, music, particularly music performed in joint action with others, is not a method of creation or communication, but one of release and catharsis.

In contrast to the views of Dunning and Freud, sociologists Durkheim and Collins conceptualize emotion as socially emergent, and forms the symbolically reproduced outcome of, and catalyst for, interactions among energized social actors (Cottingham, 2012). Collins (1990) argued that values in society are "cognitions infused with emotion" (p.27) and that these emotions serve as the mechanisms for social cohesion. Durkheim (1912/1965) described how once people come together there may be an intensification of shared experience. Durkheim stated:

> In the midst of an assembly animated by a common passion, we become susceptible of acts and sentiments of which we are incapable when reduced to our own forces; and when the assembly is dissolved and when, finding ourselves alone again, we fall back to

> our ordinary level, we are then able to measure the height to which we have been raised above ourselves (p. 157).

He called this *collective effervescence*. Durkheim (1912/1965) indicated two components to this phenomenon: shared action and awareness, and shared emotion. Shared action is the coming together of individuals where communication between people takes them out of the feeling of isolation and into a state of collective unison of thought and action. Shared emotion is described as an "avalanche" (p. 163) where the feelings of one person are intensified by sharing them with another. This then serves to intensify the individual feelings even more and creates a state of heightened connection and belief of solidarity. This intense ritual connection leaves lasting effects on both the individual and co-participants in the social group with which it was shared. The foundation for social rituals is therefore a combination of shared action, awareness of the other, and shared emotions between individuals.

Durkheim (1912/1965) states socially derived energy provides a feeling of confidence, courage to take action, and boldness in initiative, which makes the individual feel exalted and that they are doing what is most important and valuable. Social groups hold periodic assemblies in order to revivify this feeling, understanding that the experience of collective effervescence has a powerful motivating effect on the individual and will result in the desire to repeat such actions/interactions (Collins, 2004). Social rituals, therefore, operate to create and maintain solidarity within those groups. Collins calls these behaviours interaction rituals.

The requirements for successful interaction rituals are simple and straightforward: two or more people are physically assembled in the same place, there are boundaries to outsiders, participants focus their attention and energy on a common object or activity, and they share a common mood or experience. Collins (2004) furthers this by saying successful interaction rituals

include group solidarity (a feeling of membership), emotional energy (feelings of confidence, elations, strength and enthusiasm), and group symbols. The generation of emotion among group members ultimately determines the degree of longevity of a group's solidarity and its ability to maintain coherence beyond situational events.

Entrainment. The term entrainment refers to the process by which independent rhythmical systems interact with each other (Clayton, 2012). This process involves the alignment of movements in a rhythmic manner which then are able to be perpetuated without external influences. Entrainment in humans takes place on different levels: intra-personal, in which the nervous system coordinates movement across the body, and inter-personal, where individuals align movement with others in a group. Intra-personal entrainment allows performers and listeners alike to perceive metrical structures in music and to coordinate their actions in response to those structures. Clayton continues, stating, "without [intra-personal entrainment] it would not be possible for individuals to play in time with each other (i.e., achieve inter-personal entrainment)" (p. 51).

Emotional entrainment occurs when bodies are synchronized in movement and there is a mutual stimulation or arousal of participants' nervous systems. This arousal, then, results in feelings of membership that are attached to the cognitive symbols of the experience. These elements of interaction ritual are easily found within the context of music ensembles: people physically gather in a space, and there are boundaries to outsiders (i.e., in order to be a member of an instrumental ensemble one must play certain instruments at the requisite skill level). Members must consistently and positively contribute to the production of music in a pre-determined genre or style, and feelings of membership are associated with cognitive symbols such as the music itself and the sharing of a common purpose to communicate through music.

Often there is some sort of external group symbol (whether it be a logo or name, associated institution, or history/tradition of performance) and artifacts of performances and successful achievement (such as trophies, certificates, photographs, event posters). The ritual—in this case a rehearsal or performance—may be temporary, yet the effects are long lasting due to the group activity being "imbued with embodied sentiments of group solidarity, symbols or sacred objects, and individual emotional energy" (Collins, 2004, p. 36).

Collins also describes complimentary ritual components that include the physical set-up of the space and the choreographing of ritual elements that direct attention and focus, that allow for "finely-honed mimicry" of behavior (p. 76). These components are easily recognizable in the music room as the stage set-up and rehearsal/performance procedures (e.g., seating arrangements, warm-ups) and are purposefully constructed in such a way as to direct expectations and actions of musicians (for example, the warm up is specifically chosen to prepare the player for elements in the repertoire that will be focused on in the latter parts of rehearsal, or always starting/ending with a team anthem/signature piece). Individual actions are then evaluated within the contexts of the rituals against the actions of others. If the actions of the individuals match, then the ritual communication is seen as positive, and group membership is maintained and potentially promoted. When students take ownership of the ensemble experience in a unique and personal way, the regular and extensive demands of the ensemble environment provide shared goals and experiences for those involved (Morrison, 2001). These components then become ingrained into the minds of the participants and act as "gyroscopes" (Collins, 1994, p. 232) that steer individuals toward certain encounters and away from others.

The work of music education scholars Morrison (2001), Abril (2012), Matthews (2017), and Bartolome (2013) demonstrates the tangible effects of emotional entrainment and effective

interaction rituals. In their respective explorations of the social and interpersonal effects of participation of bands and choirs in school aged children, they determined that an individual's participation in music ensembles resulted in collective social enrichment through shared values, the development of group identity and feelings of belonging, a greater tolerance and acceptance to new members of the collective, and the promotion of friendships that bridged social class differences. These experiences influence individuals' willingness to continue to engage with the established rituals.

Unfortunately, not all ritual interactions are positive or successful. Some ritual interactions do not achieve collective effervescence. In these interactions, emotional and physical entrainment is not achieved, and feelings of group solidarity are decreased. One factor in this phenomenon of failed musical ritual is the inability for members of the group to synchronize movements (entrain) with others. In the conducted music ensemble, this means the individual is unable to align their performance with that of the other players and therefore experiences sensory asynchrony. Sensory asynchrony is a result of auditory, visual, and kinesthetic information not being in agreement, and may actually be perceived as a source of conflict between the individual and group (Tarr, Slater, & Cohen, 2018).

Purpose

If sensory synchrony is a key factor for successful group ritual events and positive feelings of social closeness, then a disruption to sensory information in such a way that instills sensory asynchrony should result in a failed ritual and disruption of feelings of social closeness. This leads to the following research questions:

1. Does exposure to asynchrony *negatively* affect feelings of social closeness and belonging in musicians?

2. Does the violation of the established *expectation* of synchrony affect feelings of social closeness and belonging? Are there consequences to this violation?
3. Does exposure to asynchrony shift mental focus (self-other/other-self) of the performer? Are there consequences to this shift?

In order to examine these questions, I will introduce incongruent audio-visual information to a population of adult community wind band musicians and measure the emotional responses to the resulting asynchrony, specifically on feelings of social closeness. By measuring individual responses to cognitive stress in complex sensory and social settings such as large music ensembles, I hope to contribute a deeper understanding of the relationships between music cognition, different stages in the development of sensory-motor skills, and how sensory asynchrony affects social cohesion and the desire to participate in group ritual activities like ensemble rehearsals and performances. These understandings can also be used to better inform educational decisions, support member retention and strengthen bonds within ensembles, and promote positive mental health and social practices within groups.

CHAPTER 2: Literature Review

Introduction

Interpersonal relationships are cornerstones in human society. The values of such relationships are determined by personal experience, and social groups who tend to have similar experiences will tend to have similar values and seek out similar relationships (Small, 1998). Musical ensemble performance in particular is a universal means of non-verbal communication that is achieved through specialized and codified forms of social interaction (D'Ausilio, et al., 2015). It is seen as a special type of human behavior that involves multiple individuals coordinating thoughts and movements in space and time with shared goals and purposeful outcomes (Keller, et al., 2014) while further strengthening interpersonal bonds (Stupacher, et al., 2017).

In the music ensemble, individuals are tasked to navigate a highly complex, dynamic, and temporal multi-sensory environment. Keller, Novembre, and Hove (2014) describe ensemble musicians as co-performers who coordinate their body movements to produce synchronous sounds and interlocking patterns, in which separate instrumental parts articulate different but complementary rhythms. To produce a cohesive ensemble sound, ensemble musicians attend to their own actions and those of others while concurrently monitoring the overall integrated ensemble output. These actions include the physical performance of an instrument, listening to the sounds produced by themselves and their co-performers, watching the movements and expressions of the other members in the ensemble, monitoring and evaluating the level of coordination between the various parts (e.g., different instruments, musical lines, rhythm and pulse, members of the ensemble) and actively responding to this wealth of information.

Ensemble performance, therefore, is an active and dynamic process that requires the musician to be self-aware, as well as sensitive to the other performers, and to constantly monitor and adjust their own performance in light of what is going on at any given point in time. In order to do this, musicians attend to different forms of sensory information during an ensemble performance—motor, aural, and visual—with the goal of aligning pulse and rhythm with the other members of the ensemble.

This review of literature begins with an exploration of the neuro-cognition of rhythmic joint action, also known as synchronous movement. I begin with the foundation construct of synchronous movement and entrainment, then explore how our human brains interpret and respond to sensory input in order to perform synchronous movement with others, and what happens when our brains get overloaded. Then I explore the development and reinforcement of neural networks and the behavioral consequences of reinforced actions, including those of synchronous movement as well as situations of asynchrony.

From there, the review of literature shifts to the behavioral practices and social relationships of individuals within group settings. This section begins with an exploration of belonging and bondedness theory and how they relate to the large music ensemble. Next I investigate the phenomenon of *collective effervescence* as described by the sociologist Émile Durkheim. I conclude this section with an examination of Randall Collins' theory of interaction rituals, including the positive consequences of successful ritual actions, and the negative consequences of failed ritual action in the context of the music ensemble environment.

Neuro-Cognitive Perspectives of Rhythmic Joint Action

Entrainment. The term entrainment refers to the process by which independent rhythmical systems interact with each other (Clayton, 2012). Entrainment occurs in both

biological and mechanical systems. This process involves the alignment of movements in a regular rhythmic manner which then are able to be perpetuated without external influences. A famous example of mechanical entrainment is described by Dutch physicist Christiaan Huygens. In his experiment, multiple pendulums suspended from a common support, after being nudged to move independently, became synchronized in their sway. Examples of biological entrainment include the alignment of animals' and plants' circadian rhythms with the movements of the sun and seasons, and fish and birds moving synchronously together in large shoals or flocks.

Entrainment in humans takes place on three levels: the intra-individual level in which the brain coordinates movement within the body; the inter-individual level where individuals align movement with others in a group; and the inter-group level where gatherings of multiple groups synchronize movements (for example, in sports events where different teams and their fans move and cheer together). The ability of the brain to perceive metrical structures and patterns within a piece of music (intra-individual entrainment) is the foundation of a performer's ability to coordinate their actions in response to those structures (inter-individual entrainment).

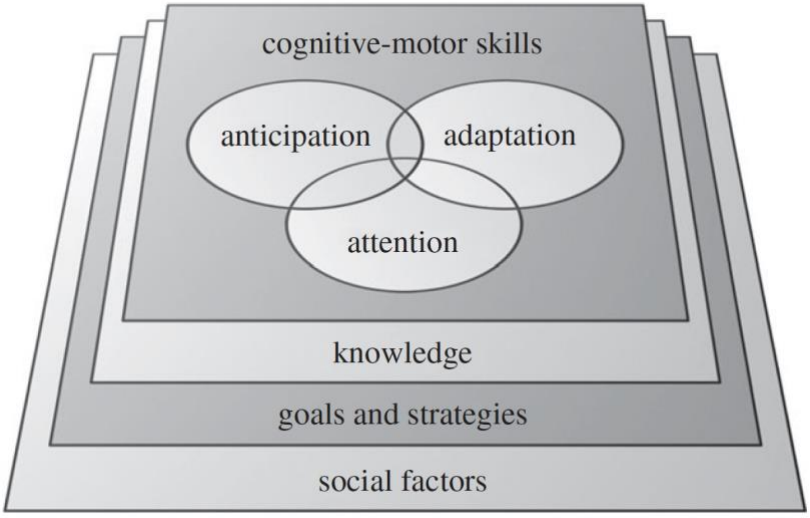
Entrainment can be symmetrical, where responses to rhythmic stimuli occur across all individuals within the system (such as an ensemble made up of responsive peers) or asymmetrical, where not all parts of the rhythmic system respond or adapt (such as when people play or dance along with pre-recorded music that they cannot influence). Entrainment can also be partially symmetrical. In partially symmetrical group situations, any individual can influence any other, but in practice some people are more likely to have influence than others and as a result, can influence the resulting strength of entrainment (e.g. conductors, section leaders, soloists, senior musicians) (Clayton, 2012). This partial symmetry of a conducted ensemble results in certain sensory information, particularly visual and auditory, becoming prioritized. Indeed, when

multiple cues are available that define the same underlying beat, humans combine the sensory information to estimate the beat structure (Honisch et al., 2016). Differences in neural activation are also observed between auditory and visual modalities in synchronization and beat perception, which indicate auditory rhythms induce an internal rhythm that guides movement, whereas visual rhythms do not generate such an internal rhythm (Jäncke et al., 2000).

Anticipation, Attention, Adaptation, and Predictability. Keller, Novembre, and Hove (2014) state, "temporally precise rhythmic interpersonal coordination requires three core cognitive-motor skills: anticipation, attention and adaptation" (pg. 2) (See Figure 2.1 taken from Keller et al., 2014). *Anticipation* involves a recognition of rhythmic patterns and the ability of the brain to predict (or anticipate) when the next "event" will take place. *Attention* involves the ability of the brain to focus on the necessary neural responses to elicit movement at the predicted time as well as evaluating the success of these movements. *Adaptation* pertains to the cognitive and motor shifts that take place in response to the relative success or failure of the preceding action. These skills are influenced by regulatory strategies that include entrainment (the synchronization of movement to externally perceived rhythm), prioritization of the focus of attention between self and others, collective adaptation (adjustment of one's performance to that of others on a group level), and phase correction. Phase correction is an automatic process that adjusts the alignment of pulses generated by an internal timekeeper in one individual relative to a sequence of pulses generated by a timekeeper in another individual. Dynamic attending, especially when employing auditory information, permits a wide range of temporally coordinated behaviors in humans (Clayton, 2012).

Figure 2.1

Factors that Influence Joint Rhythmic Action (Keller, Novembre, & Hove, 2014, p.2)



Pecenka and Keller (2011) determined individual differences in temporal prediction ability may influence the interaction of cognitive, motor, and social processes that are crucial for interpersonal action coordination in music-related contexts. To this end, Miyata and colleagues (2017) found body movements are less variable (i.e., more consistent and regular) when participants can see each other, leading to increased interpersonal entrainment during rhythmic auditory-visual-motor coordination. Such entrainment compensates for individual differences in action and enables individuals to achieve unified and cohesive performances. As a result, complex motor behaviors emerge and change according to reciprocal interactions between individuals and their environment. On that line, Thompson, Murphy, and Lukeman (2018) determined an asymmetric sensitivity in aural interactions in large groups, meaning people were more sensitive to events happening in one direction of temporal compression/decompression

(i.e., before or after their own sound). In their study on group clapping, they found individuals responded more strongly to match neighbor claps that preceded their own clap than those that followed, suggesting a natural tendency to want to "catch up" (causing the groups to speed up) and the multiplicative effect of inter-individual interactions that occurred in the effort to maintain unison.

Desantis and Haggard (2016) further suggest "predicting what sensory outcomes our actions generate may have the important consequence of promoting the temporal unity, or simultaneity, of perceptual experience" (pg. 2). In ensemble music performance, the perceptual experience includes some sort of sound production as the result of the physical action taken to play an instrument in response to a visual cue. These actions may specifically bind the motor/sound information as the expected consequence of an audio-visual cue, suggesting that learning the relation between an action and a specific audio-visual outcome drives the temporal binding of the outcome (Habets, Bruns, & Röder, 2017). Habets and colleagues determined that learning and experience resulted in a higher probability of perceiving audio-visual stimuli as simultaneous when an audio-visual combination had been encountered as compared to non-learned combinations. This difference in perceived synchrony may stem from an increased likelihood to bind previously encountered audio-visual combinations, suggesting that repetition in music performance (i.e. rehearsal) trains the brain to expect a certain congruence of audio-visual information. Neuroscientific research on perception has found that acquiring and maintaining action-outcome relations engages a specific, integrative cognitive mechanism for perceptual processing of external events (Desantis & Haggard, 2016).

Suggesting the importance of understanding one's role in an ensemble, Keller and Appel (2010) determined anticipatory imagery (knowing what is coming up in one's own and in a

partner's part and predicting how it will be performed) was a more salient factor in ensemble synchrony than isolated audio-visual information. Timmers and colleagues (2014) found that synchrony was related to body sway coordination in a manner that depended on a leader/follower dynamic. In this case, the part an individual played (e.g., melody/accompaniment) generally established which musician was the leader and which was the follower.

In conducted ensembles, there is an expectation that the conductor, the de facto leader and primary source of visual information, is absolutely "correct" and actively giving temporal information to which the musicians should align their performance. This notion is so entrenched in contemporary ensemble performance practice that the instruction to "watch the conductor" is firmly embedded in principles of rehearsal and performance pedagogy. Indeed, visual information does have certain characteristics that positively contribute to a group being able to effectively synchronize. The brain's ability to process visual information improves when there is movement in the visual field (Hove, Fairhurst, Kutz, & Keller, 2012). This suggests that conducting gestures, a form of continuous movement, are a stable and neurologically optimized form of sensory information which musicians use to determine meaning in relation to the sound they hear or expect. However, an interesting conundrum that arises in music ensembles is, when faced with unstable partners who are prone to tempo drift, the optimal neurologic strategy *does not* involve "watching the conductor" (i.e., relying on visual stimulus for pulse information). In this instance, the performer tends to adopt the role of leader by assuming responsibility for tempo and adapts less to the partner's irregular timing (Fairhurst, Janata, & Keller, 2014).

Overwhelming the Brain. Navigating the highly complex and dynamic environment of the large music ensemble in real time can come at a cost. The act of performing music can cause "sensory blocking" which overrides some senses in favor of others (Fredrickson, 1994). For

example, in a highly technical passage of music, the performer can become focused on the physical movements of their hands and body, and effectively ignore what else is being heard, and not "see" anything beyond the music on their stand, resulting in playing out of time with the rest of the ensemble. Conversely, in a lyrical passage where notes are long and sustained, a situation that is neurologically not optimal (Hove, Fairhurst, Kutz, & Keller, 2012), the performer may lose the sense of rhythmic subdivision and slow down. As such, performers are constantly trying to balance attention to their own psycho-motor challenges with the attention to the ensemble's performance and necessity to maintain synchrony.

Development and Reinforcement of Neural Networks. Socio-cognitive behaviors employed to maintain or achieve synchrony are influenced and strengthened by experience. Neural networks become more complex and robust when people experience repetition (Margulis, 2014), and expert musicians have been shown to have greater development in the brain areas related to self-other constructs, empathy, and interpersonal awareness (Keller, et al., 2014). Palmer (1997) states that, in music performance, motor systems are thought to construct the information for upcoming movements on the basis of internal concepts of time. These concepts of time can be trained through repetition; when musicians practice with a metronome, provided the individual can effectively attend to and align with the beat, they establish a connection between a steady pulse and the muscle coordination and sequence of activation required to perform the part.

Loehr and Palmer (2011) explored the influence of muscle memory and learned tempo preferences in solo study on the ability of pianists to synchronize with their duet partner. Individuals whose solo practices were more similar to those of their partner could synchronize more quickly and better than those who had different concepts of tempo. This demonstrates that

existing concepts of tempo influence ensemble synchrony, and that practice reinforces a musician's understanding and physical sensation of "how a piece goes." Repeated practice trains the muscles of the body to perform a particular movement in a particular manner. However, as Frederickson (1994) determined, this physical kinesthetic training is not isolated from visual and auditory informational associations; removing both video and audio information negatively affected a performer's ability to align with other members of the ensemble which indicates motor information, such as muscle memory, is insufficient to inform and maintain pulse in a large ensemble setting.

Movement and Self-other Representations. Neurocognitive research has uncovered mechanisms in the brain that factor into the relationship between movement and shared self-other representations. These include the recruitment of mirror neurons (Overy & Molnar-Szakacs, 2009) and a shared network of the right prefrontal, posterior temporal and inferior parietal areas (Decety & Sommerville, 2003). Mirror neurons are specialized cells in the brain that fire when an action is executed and when that same action is observed or heard, and have been intricately linked to complexities and nuances of human communication and empathy. Exploring the relationship between mirror neurons and music, Overy and Molnar-Szakacs (2009) determined that music is perceived not only as an auditory signal, but also as intentional, hierarchically organized sequences of expressive motor actions behind the signal, and that the human mirror neuron system allows for co-representation and sharing of musical experiences between performers.

Keller and colleagues (2014) suggest neurophysiological mechanisms that contribute to interpersonal coordination and perception include connections between the motor cortical regions and temporal regions of the brain and those of the auditory cortex. Adaptive timing, the

ability to attend to and respond to the movements of others, involves the modulation of neural oscillations in these networks. The resulting cognitive-motor skills of mutual temporal adaptation, attention, and anticipation are then employed to maintain synchronous movement. These processes have been linked to the activation of structures in the brain associated with socio-affective behavior and indicate a neurophysiological basis for how synchronous movement promotes social cohesion.

The right hemisphere of the brain has been linked to thinking and the perception of others and the conceptualization of self and other. Decety and Sommerville (2003) determined the right inferior parietal cortex may be crucial in distinguishing the self from other while activation of the right inferior parietal lobe correlates with the subjective sense of ownership in movement. Similarly, they determined reciprocal imitation (partners imitating each other's movements) or mentally simulating the actions of another person results in activation of the right inferior parietal lobe and right inferior parietal cortex. In a recent study by Pan, Novembre, Song, Li, and Hu (2018), the researchers determined social interactive learning can be neurophysiologically characterized through Interpersonal Brain Synchronization (IBS). Pan and colleagues utilized fNIRS (functional near infrared spectroscopy) to record brain activity in paired teacher-learner dyads while learning a song. They determined brain activity recorded from the bilateral inferior frontal cortex synchronized across the learner and the instructor. IBS was observed when the learner was both observing the instructor's vocal behavior and when the learning experience entailed turn-taking and more active modes of interaction. These results suggest that involvement in the learning experience, alongside instructors' modeling, are key factors driving the alignment of neural processes between people.

The connections between these areas of the brain allow for humans to develop and distinguish perceptions of self and other and are intricately linked to movement. Decety and Sommerville (2003) continue, stating individuals represent their own and others' goal-directed actions via a single conceptual system and these intentional relation patterns have the capacity to coordinate first-person and third-person information. However, as first-person information is qualitatively different from third-person information, it allows individuals to differentiate self from other.

This understanding of self and other can be applied to the field of music performance, particularly in ensemble settings. In ensemble music performances, the individual (self) must be keenly aware and responsive to the actions of others in order to produce and maintain a cohesive performance. Overy and Molnar-Szkacs (2009) stated music is not just a passive, auditory stimulus; it is an engaging, multisensory social activity. As musical sounds are created by movements of the human body (singing, clapping, hitting, blowing, plucking) they seem to encourage other bodies to move (clapping, tapping, marching, dancing). Group music-making involves the synchronization of physical actions with extraordinary temporal accuracy and flexibility. The context of shared knowledge and common goals seems to be a foundational component to synchronous movement in ensemble musicians (Keller, Novembre, & Hove, 2014). Shared goals ensure ensemble musicians take into account the actions of their co-performers and employ regulatory strategies that improve coordination and facilitate ensemble cohesion. By intentionally moving together, therefore, humans activate the complex neural networks that are key components to interpersonal awareness.

Synchrony and Conflict. When people participate in group synchronous movement—whether it be dance, tapping tasks, or musical ensemble performance of some type—they

consistently demonstrate more positive prosocial behaviors and feelings of empathy than those who did not (Wiltermuth & Heath, 2009; Stupacher, Wood, & Witte, 2017; Carlson, Berger, & Toivianien, 2019). Prosocial behaviors include awareness of and compassion for others, cooperation, acts of service, and a willingness to contribute toward the collective good even at personal cost. Synchronous activities have also been found to influence an individual's ability to successfully complete a task (Valdesolo, Oyang, & DeStando, 2010), as well as increase feelings of affiliation (Wiltermuth & Heath, 2009), feelings of similarity (Rabinowitch & Knafo-Noam, 2015), pain thresholds (Tarr, Launay, & Dunbar, 2016), and feelings of increased social closeness (Tarr et al., 2016; Tarr, Slater, & Cohen, 2018). This suggests the physical act of aligning one's movement with others strengthens interpersonal connections.

Although these studies did not focus on specific effects of asynchronous (or non-synchronous) movement, rather using non-synchronous movement as a contrast condition to synchrony and its associated hypotheses, asynchronous movement was not found to be socially deleterious. Although asynchrony did not promote social closeness and prosocial behaviors, it did not seem to result in distinctly negative outcomes such as feeling a lack of competence, feelings of conflict, or a disruption of interpersonal bonds. However, in the recent work by Tarr, Slater, and Cohen (2018) in the field of dance, non-synchronous movement was found to actually diminish feelings of social closeness and personal success. Indeed, sensory asynchrony is a result of auditory, visual, and kinesthetic information not being in agreement, and may actually be perceived as a source of conflict between the individual and group. They further suggest that the violation of tacit expectations of coordination experienced in non-synchronous conditions is a key contributor to disruptive effects on prosocial outcomes and feelings of togetherness.

Individual Within the Group – A Sociological View of Rhythmic Joint Action

Belonging and Bondedness. The belongingness theory (Baumeister & Leary, 1995) states human beings have a pervasive drive to form and maintain at least a minimum quantity of lasting, positive, and significant interpersonal relationships. Satisfying this drive involves two criteria: first, there is a need for frequent, affectively pleasant interactions with a few other people, and, second, these interactions must take place in the context of a temporally stable and enduring framework of affective concern for each other's welfare. They further state that networks emerge as a result of group members' pursuits of the fundamental goals to belong and affiliate. In music education, participation in performing ensembles provides this opportunity for frequent, positive interactions that inspire continued participation even through challenging rehearsal and performance schedules. Due to the inherent nature of music performance to be one of precision and production, a stable sense of community and compassion are necessary for individuals to be in a potentially critical environment and remain emotionally safe. Music ensembles tend to attract people of like-interests and skill levels, which promote a sense of similarity with others, and can result in emotionally strong interpersonal relationships.

Sociality and bondedness have been a focus of interest for both ethologists and behavioural ecologists (Dunbar & Schultz, 2010). Being able to maintain the effective functionality of a group through time may have significant implications for the individual fitness of its members. Familiar examples of this include cooperative hunting (as in social carnivores such as dolphins and wolves), cooperative rearing (as in many birds such as penguins) and group-living as a defence against predators (as in many primates, elephants, and musk ox). Failure of an individual group member to maintain coordination and collective focus may undermine the effectiveness of the group to achieve its intended function and have consequences

that extend to the individual. Dunbar and Schultz refer to this as dung-fly model of sociality—individuals distribute themselves (and their contributions) in response to the shifting balance of the moment-by-moment costs and benefits of being in a group. The amount by which individuals are willing to compromise their immediate interests in order to maintain the integrity of the group depends precisely on the benefits conferred by the characteristics of the group. As social cohesiveness increases, the options available to an individual are increasingly constrained by the needs of other group members. Individuals may then be locked into the effectiveness with which their social group functions.

In music ensembles, this balance between individual and collective is experienced in every rehearsal setting. The musicians contribute their individual skills on their instruments and understanding of the music presented before them to the collective group performance in any given moment. As described in the animal examples above, failure of an individual to accurately perform their part (i.e., the intended function of that instrument) undermines the effectiveness of the group performance. Members of an ensemble are expected to attend regular rehearsals in a consistent, timely, and mindful manner. As such, the individual must be willing to create that time in their personal schedules in order to participate, and the individual must find enough benefit in the collective experience to continue to participate in a regular and consistent manner. Members of large music ensembles such as marching bands, often dedicate hours of rehearsal time per day, up to six days per week during athletics seasons, in order to represent and support their teams. This is a notable display of individual sacrifice in order to experience the benefits of group membership such as interpersonal connection, belonging, and acceptance which extend over long periods of time (Matthews, 2017; Lorenz, 2019).

One aspect of bonded relationships is the need to coordinate and synchronize behavior (Dunbar & Schultz, 2010). Behavioral synchrony requires physical connectedness through shared activity and interests, and social monitoring. This monitoring allows individuals to adjust their behaviour to that of their partners, but only if the individual is paying attention. Hence, social monitoring of other group members (and the extent to which this is reciprocated) may be a particularly useful index of the extent to which individuals are bonded within the group.

Durkheim and the Phenomenon of Collective Effervescence. French sociologist, Émile Durkheim (b. 1858, d. 1917) developed a vigorous methodology of empirical research and sociological theory. His preeminent document, *The Elementary Forms of Religious Life* (1912/rev. 1965), based on his observations of religious ritual practices in Australia, has become the foundation of social ritual theory and understanding group behavior. In it, Durkheim posits that religion is the collective represented in symbolic form.

Durkheim describes society as an entity in and of itself. This entity is a composite creation of the values, activities, and collective behaviors of the community. Because it has a nature that is separate from that of the individual, society arouses the sensation of perpetual dependence (p. 154). It "imperiously demands our cooperation" and requires the individual to set aside their own needs or desires and submit to collective rules of thought and behavior in order to effectively participate within the bounds of the society. However, this form of individual submission is a result of respect of the collective rather than fear of physical repercussion.

Through this lens of respect, an individual's behaviour is duly echoed by others in the collective. This shared representation of importance has an intensity that is augmented from that possible by a single individual. This collective "voice," then, has a resonance that is far greater than that of the individual; society exists in and through the minds of its members. All facets of

society must become organized inside the individual, thus becoming an integral part of their being, and in so doing, elevates and enlarges that being. This is reassuring and invigorating, and propels the individual to further participate in collective actions.

A key edict of Durkheim's work is something he calls *collective effervescence*. This sensation is a result of emotional intensification through shared experience. He stated:

> In the midst of an assembly animated by a common passion, we become susceptible to acts and sentiments of which we are incapable when reduced to our own forces; and when the assembly is dissolved and when, finding ourselves alone again, we fall back to our ordinary level, we are then able to measure how far we were raised above ourselves. (p. 157)

Durkheim indicated two components to this phenomenon: shared action and awareness, and shared emotion. Shared action is the coming together of individuals where communication between people takes them out of the feeling of isolation and into a state of collective unison of thought and action. Shared emotion is described as an "avalanche" (p. 163) where the feelings of one person are intensified by sharing them with another. This then serves to intensify the individual feelings even more and create a state of heightened connection and belief of solidarity. When combined, shared action and awareness of the other, and the shared emotions between individuals, create a state of intense emotional experience that leaves lasting effects on both the individual and the co-participants in the social group with which it was shared and are the foundation for social rituals. He further states socially derived energy provides a feeling of confidence, courage to take action, and boldness in initiative which makes the individual feel exalted and that he/she is doing what is most important and valuable.

Large music ensembles are microcosms of society; one can even argue they are societies unto themselves. In these groups, individuals must submit to the vision of the collective, informed by the rules of conduct, traditions, power hierarchies, and the literal demands of the music being performed. These behaviors and thought patterns become ingrained into the being of the individual and persist over time (e.g., the "hard core band kid" and the expression "Band Geek Forever!" (Abril, 2012)). Participation in music ensembles is a form of shared action, reinforced by regular repetition (e.g., weekly rehearsals), and, in combination with the release of dopamine, the neurotransmitter associated with pleasure and reward, that is elicited by music performance (Ferreri et al., 2019), creates a strong sense of solidarity, belonging, and commitment to the collective. Members of these ensembles then prioritize their time in order to maintain participation and membership within the group.

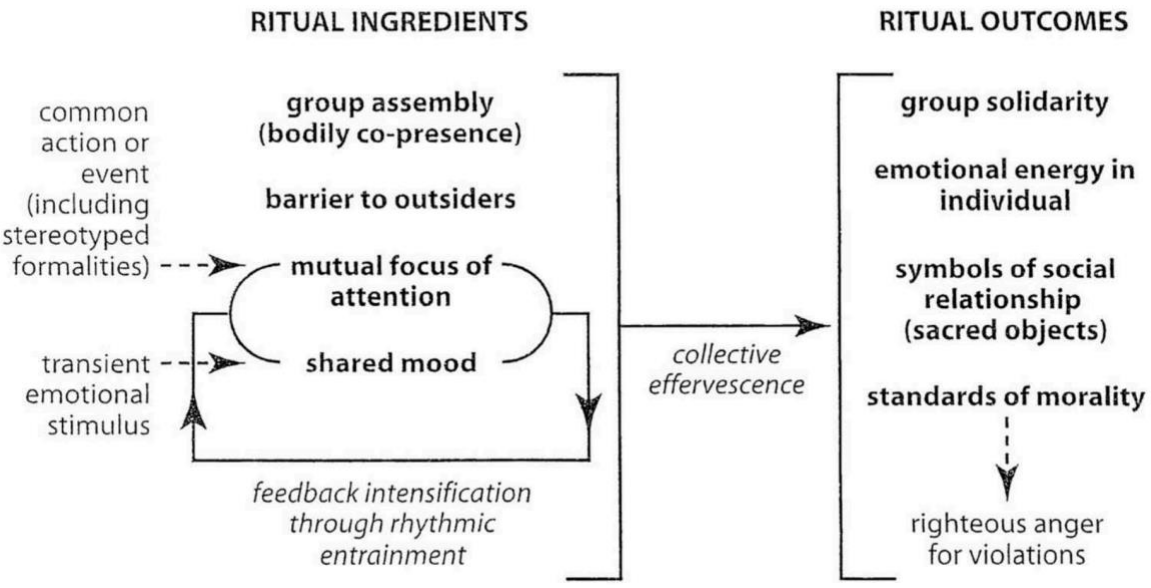
Collins' Interaction Ritual Theory. Randall Collins (b. 1941) is an American sociologist who focuses on micro-sociology. Micro-sociology is an exploration into the micro world of every-day interactions. Through this focus on every-day interactions, Collins examines the role that emotions, rituals, and routine encounters play in social life. He argues that a construct he calls *interaction ritual chains* (2004) underpins much of human micro-level relations. In this view, social actions are shaped by the emotional energies displayed in face-to-face encounters where high energy individuals tend to direct much of these collective interfaces. Interaction ritual chains involve social mechanisms through which individuals and groups generate symbols of group membership that, in turn, increase their individual and collective emotional energies.

Social rituals operate to create and maintain solidarity within groups. Collins posits situations of high emotional intensity attained through social rituals generates the state of

collective effervescence, characterized by focused group attention and synchronic rhythms of bodies and minds. As such, social groups hold periodic assemblies in order to revivify this feeling, understanding that the experience of collective effervescence has a powerful motivating effect on the individual and will result in the desire to repeat such actions/interactions (see Figure 2.2).

Figure 2.2

Model of an Interaction Ritual (Collins, 2004, p. 48)



The requirements for successful interaction rituals are simple and straightforward: Two or more people are physically assembled in the same place, there are boundaries to outsiders, participants focus their attention and energy on a common object or activity, and they share a common mood or experience. Collins furthers this by saying successful interaction rituals include the promotion of group solidarity (a feeling of membership, moving in synchrony),

directed mutual focus of attention, high emotional energy (feelings of confidence, elation, strength and enthusiasm), and specific use of group symbols (p. 76). The generation of emotion among group members ultimately determines the degree of longevity of a group's solidarity and its ability to maintain coherence beyond situational events.

The regular rehearsals and performances of music ensembles are effectively interaction rituals. There are more than two people physically present—in some ensembles such as marching bands, groups can be hundreds of members in size, and there are boundaries to outsiders that take the form of being able to play specific instruments at a specific level of proficiency (e.g., auditions), or the requirement to provide your own instrument or pay a membership fee (e.g., adult community bands). The common purpose can be literally stated as effectively realizing in sound the written music presented at a rehearsal gathering but is more generally stated as playing music together. Voluntary participation in music ensembles, particularly those of collegiate and community settings where individuals face significant demands on their time and energy outside of the rehearsal context (i.e., real-life as an adult), require the mood and energy of the group to be positive and supportive, and rehearsal experiences must predominantly instill feelings of shared goals and group achievement. Music ensembles also have group symbols, such as logos, specific colors, uniforms, trophies of past victories, photos of past events, and signature songs/pieces.

Collins goes on to state the common focus of attention and rhythmic coordination that intensifies emotions can be frustrated by persons who attempt to control the situation (p. 121). They can break the micro-rhythm of the group interaction by not responding to the signals others are putting out (e.g., ignoring or overriding non-verbal cues). These actions prevent the circular build-up of anticipations and break down feelings of group membership. In music ensembles,

this may occur when individual members are unable to perform their part at the expected level of the group, repeated mistakes even after instruction or guidance, or a lack of reciprocal response between conductor and ensemble.

As such, not all ritual interactions are successful. In these unsuccessful interactions, emotional and physical entrainment is not achieved, and feelings of group solidarity are lessened as a result. Collins (2004) describes these interactions as failed rituals. Failed rituals are marked by low energy, a sense of "drag" or constraint, individuals drifting away from the group, and a lack of mutual attention. Repeated failed rituals can result in fragmentation of the group. This is something that unfortunately does occur with music ensembles, and results in members becoming excluded (Elpus & Abril, 2011), feeling ridiculed or fearful, and taking on the behaviors of learned helplessness (Allsup & Benedict, 2008).

Conclusion

Feelings of social closeness can be influenced by neuro-cognitive and sociological factors. These neuro-cognitive factors include physical and emotional entrainment, anticipation, attention, adaptation, and predictability of sensory information within a dynamic and temporal environment, cognitive load, the positive effects of synchronous movement on self-other constructs and prosocial behaviour, and the possible negative effects of asynchronous movement on feelings of social closeness. Sociological factors that influence feelings of social closeness include belonging and bondedness, the phenomenon of collective effervescence, and effective interaction rituals. Failed rituals have been shown to erode feelings of membership and group solidarity, which result in the individual losing respect for the group and its symbols and avoiding group participation.

When explored as a whole, these different facets of rhythmic joint action suggest that the neuro-cognition of the individual can influence group social dynamics, and those can affect the emotional and physical states of the individual and how they perceive other members of the group. To this end, I applied a cognitive research approach to an interaction ritual environment, with the goal to answer the following research questions:

1. Does exposure to asynchrony *negatively* affect feelings of social closeness and belonging in musicians?
2. Does the violation of the established *expectation* of synchrony affect feelings of social closeness and belonging? Are there consequences to this violation?
3. Does exposure to asynchrony shift mental focus (self-other/other-self) of the performer? Are there consequences to this shift?

The method, informed by the literature described above, alters the expected auditory and visual stimuli experienced in a real-time rehearsal setting of a large, adult music ensemble and creates a condition of audio-visual asynchrony. Responses to the introduction of audio-visual asynchrony were measured in accordance with the methods and tools used by researchers in this field, and analysed for significance using statistical methods and open-ended personal commentary.

CHAPTER 3: Method

In this study, I tested the effects of audio-visual asynchrony on feelings of social closeness in adult community band musicians. The large instrumental ensemble environment is a complex and dynamic system of sensory input and, generally non-verbal, interpersonal communication. The ability of an individual to be aware of these complexities, and then successfully adapt their performance as necessary, is a hallmark of skilled participation and high-level cognition (Keller, Novembre, & Hove, 2014).

Method

This study is largely based on the "Silent Disco" study completed by Tarr, Launay, and Dunbar in 2016. In this study, they determined that asynchrony may be interpreted as a perceived "other" and source of conflict. Their study utilized virtual reality and motion capture technology to simulate dancing in pairs. Tarr and colleagues utilized a within-subjects, repeated measures design with multiple levels of asynchrony. In their study, participants experienced synchronous movement through identical dance choreography and music, partial asynchrony with participants hearing the same music but choreography was different, and full asynchrony where music and choreography were different. They tested multiple hypotheses related to the effects of moving together on feelings of social closeness and pain reduction across all three synchrony conditions.

My initial attempt into adapting their platform of varying degrees of asynchrony to the wind band environment involved participants playing a piece of music (one part of a 4-part chorale) on their own instruments while watching a video of a conductor and listening to a soundtrack of a concert band playing the complete four-part chorale. The audio soundtrack was manipulated to play back the different lines of the chorale (i.e., soprano, alto, tenor, bass) at

different rates, from fully synchronous, partial asynchrony where the first two and last two bars of the chorale were synchronous and the middle 12 bars gradually increased then decreased in asynchrony, and full asynchrony where only the first two bars were synchronous and the remaining 14 bars were asynchronous. The conductor video remained stable in tempo and pattern throughout each audio condition in order to create the condition of audio-visual asynchrony. Pilot participants (N = 5) unanimously remarked they did not feel connected to their virtual bandmates or to the conductor, even in synchronous conditions, a stark contrast to the findings observed by Tarr and colleagues (2016). This result suggests feelings social closeness were likely never established, perhaps due to the artificial nature of the task, or to the brevity of the interface (each participant played along to each of the three study conditions, roughly 5 minutes in total time). As the purpose of this study is to examine the effects of audio-visual asynchrony on feelings of social closeness, it was important that any design utilized must first engender feelings of social closeness.

In order to address the necessity for participants to start from a state of social closeness and to keep the study context as ecologically valid as possible, I chose to work with intact, live ensembles. By using intact ensembles, I was able to control for the valence of existing feelings of closeness and familiarity through the use of a pre-test/post-test analysis model. This is in line with the recommendation by Tarr, Slater, and Cohen (2018) who suggested future studies on the effects of asynchrony on feelings of social closeness should incorporate baseline measures to isolate positive effects of synchrony and/or negative effects of asynchrony. Given a secondary question of the present study pertains to the influence of experience on feelings of social closeness, it was also important to work with a sample population that had multiple intact

ensembles of different ages and experience levels that were demographically diverse but socially familiar with each other.

Participants. I was specifically interested in the behaviour of adult community musicians as this population chooses to participate in group music-making as part of their leisure activities, and there is a wide range of backgrounds, abilities, musical experience, and personalities. A common denominator in community music ensembles is the love of music and desire to participate in regular meetings (i.e., weekly rehearsals) (Higgins, 2012). The test sample (N = 163) for this study came from the bands of the Cosmopolitan Music Society (CMS) in Edmonton, Alberta, Canada. This sample is deemed representative of adult community band performers due to its range in participant ages (18-88 years old), experience and skill levels (beginner to advanced), and "working-life" backgrounds (labourers, professionals, academics, trades, etc.). The Cosmopolitan Music Society (CMS) was created in 1963 as a place for adult community musicians to gather and make quality music. Over its 56-year history, CMS has grown from one concert band to one of the largest community music organizations in Alberta, with four concert bands, two jazz bands, and a large mixed chorus. At the time of this study, CMS had 368 members across all ensembles. Instrumental ensembles are leveled according to musical skill (beginner, novice, intermediate, and advanced concert bands, and standard and modern jazz bands).

For this study, participants were members of the four large conducted instrumental ensembles (wind bands): *N*s: Beginner = 17, Novice = 46, Intermediate = 54, Advanced = 46. The study sample is representative of the overall population of the CMS instrumentalists, however, due to the time of year when the data was collected (January-February 2020), weather and seasonal illness, sample size is lower from that of the complete ensemble membership. For

example, the beginner band has 25 members when all are present, while the novice and advanced bands have over 60 members, and the intermediate band, 75. The concert bands were chosen over the jazz bands for members' comfort and familiarity with a conductor, and their general comfort and familiarity with traditional chorale-style music.

A vital key to this study is the knowledge and familiarity of the ensembles with each other, and with me. As a CMS conductor, [1] I know these people and they know each other. The beginner group is in Year 2 of the CMS Beginner program and has been playing together for 16 months. Other members of CMS have been with their respective ensembles, in some cases, for over 40 years. Although there is some turn-over in membership from year to year, each group had been intact since the beginning of the CMS rehearsal/performance season in September 2019. Given the core research question is to examine the potential detrimental effects of asynchrony on social closeness, it was important to work with a sample population who have established relationships within their respective groups, and who felt safe with me as a researcher. I did not want my presence as a researcher to inadvertently influence the dynamics of the group either by increasing feelings of closeness due to a possible collective uncertainty or distrust of the (new) conductor prior to commencing the study, or through instilling a fear of judgement or failure which could affect the individual ability to perform mindfully (e.g., Carlson, Burger, & Toiviainen, 2018; Allsup & Benedict, 2008).

Group Demographics. Table 3.1 is a breakdown of the ages and experience (in years) on their instrument by group. Although differences in feelings of social closeness by gender is not a

[1] I am the Music Director of CMS and have been at the helm since 2014. I am the main conductor of the Monday (advanced) Band, and I have had the opportunity to interact with and conduct all members of the Society at some point. Given my residence in Seattle, Washington Between August 2017 and July 2019 as I completed my doctoral course work, there were members who have joined within the past two years whom I had not conducted directly. These people do know me as Music Director, however.

focus of this study, it is important to note that groups are generally split evenly between females and males. In the novice and advanced groups, however, 13 people did not disclose their gender or age.

Table 3.1

Breakdown of Mean Ages and Experience in Years by Group

Group	*N*	Mean Age (years)	Mean Experience (years)	*SD*
Beginner	17	53.65	1.53	0.62
Novice	46	58.13	6.81	4.11
Intermediate	54	52.58	17.33	13.40
Advanced	46	48.06	32.71	13.89

The beginner ensemble (9 female, 8 male) received the label A as they were the first group to complete the study. Members in this ensemble are new to their respective instruments, but not necessarily to music. Many of these members are older retirees who now have time to learn a new instrument. Based on my experiences with this group, through both casual conversations and the opportunities I have had to instruct the group, members of this group tend to be sophisticated consumers of music—attending symphony, opera, and other live popular music events. Some have children involved in music or dance in some way. There were three secondary music teachers in this ensemble who are developing their skills on secondary and tertiary instruments.

The novice group (25 female, 17 male, 2 non-binary, and 2 not identified) received the label C as they were the third group to participate in the study. This group is made of members who have recently completed the CMS beginner program, who are in the early stages of skill

development, are older adults who experience difficulty with the technical demands of higher level music (e.g., lung capacity and finger dexterity affected by age or illness), and whose occupational demands or family commitments do not allow for regular home practice (e.g., stay-at-home parents, live in an apartment or residence, frequent travellers, shift-workers). The novice group self-describes as having an overall focus on the enjoyment of group music-making. Although this is similar to the sentiment described later by the intermediate band, due to the lower skill set, the novice band is highly focused on collective musical development and cohesive expression rather than social engagement and "playing music with friends."

The intermediate level ensemble (32 female, 22 male) received the label B as they were the second group to complete the study. In conversation with intermediate band members, they describe themselves as generally motivated by the social aspects of playing in a band, and although the members highly value public concert performances, the focus during rehearsals tends to be that of enjoyment rather than perfection. As the largest of the CMS instrumental ensembles, it also has the greatest diversity in membership, with its youngest member being 18 and its oldest 88 years old, and the most variety in cultural (e.g., Canadian, Indigenous, European, African, South-American, Asian, Middle-Eastern, American) and occupational backgrounds (e.g., professional – medical, education, legal, business; trades, academics, students, self-employed, stay-at-home parents, artists).

The advanced group (22 female, 13 male, 11 not identified) received the label D as they were the last group to participate in the study. These members are dominantly musicians with university level training on their instruments and who have extensive ensemble experience, often beyond the community music paradigm (e.g., professional pit-orchestra and symphony orchestra wind sections, military, studio and school/college music educators). This group is motivated by

musical excellence and high-level performance expectations and opportunities, including international tours, festival performances, and premieres of commissions and new works for band. Socially, the advanced ensemble tends toward small pockets of social groups, particularly between members who have been part of the ensemble for many years. However, there is a strong sense of collaboration and shared purpose within the ensemble.

A final aspect of the study sample that required an extra level of control is that of multiple group membership as a few of the members of CMS play in multiple ensembles. Some play different instruments with different ensembles, and some play the same instrument but a different part. For example, they may play their primary instrument with the advanced band, and a secondary instrument with the intermediate or novice group, or play 3rd clarinet with the advanced band and 1st clarinet with the intermediate band. In order to control for exposure to the study as a result of multiple group membership, I asked participants who had already completed the study with another group to not participate again. Participants in this situation (n = 7) were asked to not complete the study questionnaire again and to not reveal the nature of the study to their fellow bandmates. All affected members complied with instructions and did not participate a second time. Demographic information including years experience on that instrument was collected based on the ensemble with which they completed the study. Five participants were on the same instrument, just different parts, and 2 participants were on their secondary instruments.[2]

Data Collection Tool. This study measures feelings of social closeness quantitatively through the calculation of the Social Closeness Index (SCI) score (Tarr, et al., 2016), combined with an exploration of interpersonal challenges that may affect feelings of social closeness, and a

[2] As both members on secondary instruments were in the intermediate band when they completed the study (2/54), the difference made to mean years experience calculations in their primary ensemble (N = 46) and secondary ensemble should be negligible.

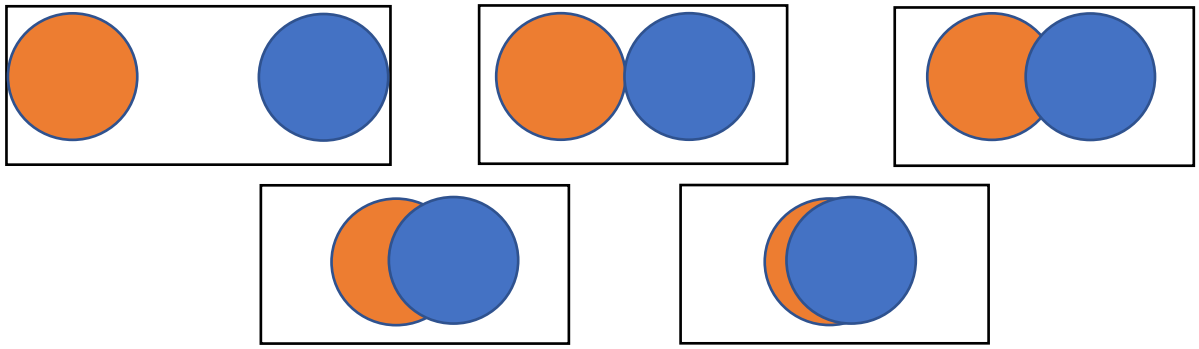
qualitative examination of feelings through an open-ended response to the study experience. The data collection tool takes the form of a 14-item paper questionnaire.

The Social Closeness Index score consists of responses to the following 10 questions (see Appendix A for full questionnaire). These items were taken directly from Tarr and colleagues (2016) and modified to the band setting (Figure 3.1).

Figure 3.1

Items Used to Create the Social Closeness Index (SCI)

1. Of the five pictures shown below, choose the one that best depicts your relationship to the other members of the ensemble **right now**.



2. How connected do you feel to the other participants?
3. How likeable were the other participants in the ensemble?
4. To what extent do you feel similar to the other members of the ensemble?
5. In your opinion, how successful were you at synchronizing with the conductor?
6. In your opinion, how successful were you with synchronizing your performance with others?
7. How would you rate your <u>expectation</u> of playing in synchrony (together with the group) **before you began**?
8. How well was your expectation of playing in synchrony (together with the group) met during this rehearsal?
12. How enjoyable was this rehearsal?
13. If this is generally how rehearsals go, would you want to rehearse or perform with this ensemble again?

Scoring was completed using a 5-point Likert scale for SCI questions with responses from 1 = not at all to 5 = very much.

Hove and Risen (2009) found that task difficulty and overall task enjoyability even in asynchronous conditions did not correlate to feelings of likeability between participant and partner. However, Collins (2004) described that in situations of failed ritual, where emotional and physical entrainment is not achieved, feelings of group solidarity are decreased. Interestingly, the construct of blame as a reflection of self-other awareness, belonging and group solidarity is not discussed specifically in either Hove and Risen (2009) or Tarr et al. (2016), and only suggested by Collins (2004). As such, I included a sub-set of questions designed to confirm the results of Hove and Risen (2009) and to more deeply explore these potential negative influences on feelings of social closeness. The following three questions were scored on a 5-point Likert-type scale, with the first two questions ranked as 1 = not at all and 5 = very much, and the last as 1 = me to 5 = others.

1. How difficult was it to perform with this group?
2. How uncomfortable or embarrassed did you feel during the rehearsal?
3. Who do you think is at fault for mistakes made during this rehearsal?

A final open-ended item was added at the end of each questionnaire in which participants were asked to describe in a few words how they felt during this rehearsal.

Experimental Design. In order to test the effects of asynchrony on social closeness within large instrumental ensembles, I chose to isolate the visual aspect of the multi-sensory, real-time, ensemble environment using a pre-test, post-test experimental design. This design uses a pre-test to function as the within-subjects control and provides a baseline for comparative analysis. The experimental stimulus was introduced to the participants. At the conclusion of

stimulus interaction, participants completed a post-test which was scored for differences in response from that of the baseline.

In my previous research (Lorenz & Morrison, 2019) we found that, in situations of conductor and ensemble temporal asynchrony, participants were as likely to rely on auditory information as visual information in sustaining the temporal coherence of their performance. However, visual information is referenced by the participants for indications of tempo, changes to established pulse, and as a general means of support as they navigate the multi-sensory environment of an ensemble performance. As such, disruption to the sensory environment was purposefully introduced via the conductor.

Another factor in the decision to only manipulate the visual information communicated by the conductor is that it preserved the expectations of the written music from the point of the player. Modern written music is treated as a set of specific instructions from the composer to the player, and the player's responsibility is to perform the written music as indicated. This includes everything from accuracy in pitch and rhythm, to dynamics, tempo, and articulation. By adhering to these markings, the musician is able to realize the vision of the composer. As mentioned throughout this study the implicit expectation of ensemble performance is one of synchrony and temporal alignment, and music performed without precision and attention to group synchrony is considered deficient (Palmer, 1997). As such, players in this study approached the music provided with the expectation of cohesive, homogenous musical performance in every part of the study. By maintaining participants' expectations as laid out by the written music, this study therefore measures only the player's emotional responses to the experienced audio-visual asynchrony.

Procedure. After receiving written consent from each participant in accordance with IRB regulations of the University of Washington, participants were given the study materials which included a page of printed music and the questionnaire booklet. Data collection via the questionnaire was completed in response to the different conditions of the study, initially at the conclusion of the synchronous control condition, and subsequently after the audio-visual asynchrony (treatment) rehearsal condition. Both identical questionnaires were included in a single booklet in order to keep control and treatment data connected. Participant numbers were assigned post-hoc by group and collection order.

The study music, titled "Chicago Chorale #4" was an unpublished arrangement of the four-part hymn *DUKE STREET*, written in 1793 by English composer John Warrington Hatten. This arrangement for concert band was completed by Garry Silverman, former director of the Cosmopolitan Music Society, who discovered this tune at a workshop at the Midwest Band and Orchestra Clinic held annually in Chicago, Illinois. I chose this piece because the rhythms and ranges across all parts were appropriate for beginner players. The piece is homophonic in texture (all parts moving at the same time and rhythm) with each of the four, 4-bar phrases beginning on a downbeat. It is written in common time (4 beats to a bar) and had no expressive or tempo markings indicated on the written music. Members of the band received one of the four parts (soprano, alto, tenor, or bass marked as such on their parts), with key signatures and clefs appropriate to their instrument. (See Appendix B for conductor score). The four parts were evenly distributed across the ensemble, and parts were assigned in accordance to the role played by the different instruments in the band (e.g., flutes received the soprano part and tubas received the bass part).

Participants were instructed to take a few minutes to familiarize themselves with the piece. The beginner ensemble took approximately 5 minutes to complete this process, while the advanced ensemble took less than a minute. Participants were asked to show they were ready to continue by placing their instruments on their laps once they felt comfortable with the music in front of them. After participants had completed their self-practice, they were informed of the remainder of the study procedure. I reviewed the questionnaire booklet with them and instructed them to only complete the requisite section upon invitation. The chorale would be performed four times, with data collection taking place after the second and fourth time through the piece. Participants were informed that the entire study should take approximately 25-30 minutes to complete.

The first two play-throughs of the chorale were treated as the synchronous control or baseline, henceforth called the pre-test. Initially, participants were invited to raise their instruments with my instruction "Let's play." The second play-through began with the instruction "Let's play it again!" The conductor, in each case, me, conducted the group both times at a moderate and comfortable pace (approximately 100 beats per minute) with consistent and predictable gestures and breaths between each phrase.[3] Predictability refers to a conducting gesture that effectively indicates when and how to play the next note or phrase. This information is communicated through acceleration and deceleration toward and from the beat point, direction of rebound, magnitude of rebound, change in direction and the location in space where that change occurs. This approach is consistent with expectations placed upon the conductor to provide information on starting/stopping, setting the pulse, and supporting the players through

[3] Reliability of these statements comes from my experience as a veteran conductor with years of training and instruction from highly critical teachers. Although I did not record the study, based on the cohesive performances of each ensemble, I am confident that my affect, gesture, and breath were consistent and effective in communicating pulse and general style.

the performance. Upon completion, players were asked to complete part one (pre-test) in their questionnaire booklets.

Verbal instructions for the experimental condition were the same as in the control condition ("Let's play;" Let's play again"). This was intentionally done in order to maintain consistency between conditions and to not inadvertently prime the participants for changes. The third and fourth times through the piece I altered my gestures to become unpredictable while still maintaining a typical 4/4 conducting pattern. This was achieved through changing tempo by accelerating or decelerating with no reference to the music or traditional performance practice (such as slowing down at the end of the piece), stopped gestures without rebound, or gestures without a defined beat-point (see Appendix C for asynchronous conductor score). Although acceleration and deceleration both connote an element of predictability (i.e., progressively getting faster or slower) I varied inter-onset intervals (the time between beats) (IOI) both in this more "patterned" way as well as with individual IOIs shortened and/or lengthened. Stopped beats refer to a complete lack of rebound and preparation (meaning the baton did not bounce or lift to indicate when or how the next beat was going to take place), while undefined beat points refer to gestures that change direction without a specific location in space and time between direction change.

These disruptions to the visual information produced by the conductor were designed specifically to lack the predictive aspects of conducting gesture, while still being congruent with the expected rhythm and pulse implied by the written music. As such, this disruption was constrained to the features of conducting gesture specific to communicating what is coming next, thus affecting the ability of the participant to anticipate and adapt their individual performance (as per Keller, Novembre, and Hove, 2014). As a result, the visual information became unpaired

with the auditory information (the music produced). Upon completion of the second set of play-throughs, participants were asked to complete part two (post-test) of their questionnaire.

Data Analysis Plan

Questionnaire data was analysed using both quantitative and qualitative techniques. Quantitative analysis was conducted to explore differences between the control and treatment responses in multiple ways. The first is the determination of the Social Closeness Index Score, then per item analysis of its composite elements. Next, the three items within the interpersonal challenges category were explored on a per item basis through an analysis of group mean differences between pre- and post-test. Although this study is generally quantitative in nature, a final qualitative analysis of the open-ended response was conducted as a way to understand the experiences of the participants and add detail to the quantitative results. Data analysis was completed using a combination of Microsoft Excel 2016, and SPSS Version 26 (2019).

Quantitative Analysis. Quantitative questionnaire data was transcribed to an Excel workbook by question. There was a total of 26 items, 13 items from each administration of the questionnaire. Mean scores, standard deviations and effect sizes were calculated for each item. Items used to create the Social Closeness Index Score (Questions 1-8, 12, and 13) were combined into a single value per participant. This value was derived in the same manner as Tarr, Launay, and Dunbar (2016). Internal validity for these items was calculated using Cronbach's α for both pre-test and post-test. As there are a large number of data being combined into the SCI scores, assumptions of independence, normality, homogeneity, and linearity are maintained. Therefore, a repeated-measures, between-subjects ANOVA was run to determine if there were any differences between the groups. Post-hoc follow-up t-tests with a Bonferroni correction to control familywise Type I error was completed to determine specific group differences.

In order to examine the nuances of the SCI elements, I examined each question on its own, focusing on group differences. Given the ordinal nature of Likert-type data, examining the data on a one-item level violates the assumptions of parametric tests. As such, I used the descriptive statistics to inform the qualitative discussion of the results, with a particular focus on group trends and differences.

To further explore the relationships between experience and group membership on Social Closeness Index scores, I completed a multiple linear regression analysis with sequential predictor entry. Sequential predictor entry specifically allows for testing incremental variance accounted for as predictors are added to the model. Normality, linearity, and homoscedasticity of residuals were examined for each model to ensure that linear regression model assumptions were tenable. As this sample was drawn from a large single population, independence was also tenable. For this analysis, the dependent variable was the Social Closeness Index post-test score while Block 1 included the standardized Social Closeness Index pre-test score, Block 2 included the standardized years experience, and Block 3 included group membership. Group membership was dummy coded (0 and 1, with 1 being membership in that group). The final general model was as follows.

$$YSocialCloseness = b_0 + b_1*ZSocialClosenessPre + b_2*ZYearsExp + b_3*(1)Group1 + b_4*(0)Group2 + b_5*(0)Group3 + b_6*(0)Group4.$$

In this model, post-test social closeness is equal to the conditional mean (b_0), plus the unique effects of pre-test social closeness index score (b_1), the unique effects of years of experience (b_2), and the unique effects of group membership (b_3 - b_6). Finally, follow-up paired t-tests were conducted between groups 1 through 4 to determine any significant differences between group means with a Bonferroni correction for familywise Type I error.

Items included in the interpersonal challenges set of questions (items 9-11) were approached in the same manner as the elements of the Social Closeness Index. Internal validity of these items was calculated using Cronbach's alpha. These items were treated as individual constructs, however, and was not combined into a single score. A comparison of pre- and post-test descriptive statistics was completed to inform a qualitative examination of trends and differences between groups.

Qualitative Analysis. Item 14 reads, "In a few words or short sentences, describe how you felt during this rehearsal." Answers were transcribed verbatim into an Excel spreadsheet. From this spreadsheet, responses were coded according to the strategy recommended by Creswell (2015) who describes the qualitative coding process as "segmenting and labelling text to form descriptions and broad themes in the data" (p. 242). As such, data were divided into segments (codes), then examined for redundancy and overlap. From there, these codes were collapsed into broad themes. This inductive process of narrowing data into a few themes results in a rich description of the participants' environment that lends itself to a deeper understanding of the quantitative findings. Frequency and repetition, segment grouping, and thematic categories were independently verified by a non-participant scholar who has background in ensemble music performance and music education. A further analysis of qualitative comments by group membership and correlation with SCI score was completed in order to determine any patterns in responses and the strength of the relationship that exists between qualitative and quantitative findings.

CHAPTER 4: Results

In this study, I employed a pre-test/post-test design in order to measure the effects of audio-visual asynchrony on feelings of social closeness within large community wind bands and answer the following research questions:

1. Does exposure to asynchrony *negatively* affect feelings of social closeness and belonging in musicians?
2. Does the violation of the established *expectation* of synchrony affect feelings of social closeness and belonging? Are there consequences to this violation?
3. Does exposure to asynchrony shift mental focus (self-other/other-self) of the performer? Are there consequences to this shift?

This design allows for the pre-test to function as a control and baseline, as it measures the feelings of the participants in a typical rehearsal setting and activity. The post-test scores were gathered after completion of the "treatment" condition, in this case, the introduction of visual asynchrony by the conductor.

The measurement tools that were used to determine feelings of social closeness included the Social Closeness Index (SCI) score, analysis of interpersonal challenges, and a personal response to the experience. The instrument consisted of a 14-item paper questionnaire that was administered twice, first after the control rehearsal, and again after the treatment (asynchronous) rehearsal. Thirteen of the items were quantitative in nature and measured on a 5-point Likert-type scale. The final question was an open-ended qualitative response to each rehearsal condition where participants were encouraged to write a few words or sentences that described their feelings and responses to the different conditions. Both sets of questions were identical and

contained within the same booklet. Booklets were labelled post-hoc by group and order in which they were received as a way to assign the anonymous participant number that was used for analysis and to keep track of data responses.

Quantitative Analysis

Social Closeness Index. The Social Closeness Index is a composite measure made up of elements which prior research has demonstrated to contribute to the construct of social closeness. Using the strategy outlined by Tarr, Launay, and Dunbar (2016), I used the elements of inclusion of self in other, connectedness, similarity, likeability, enjoyability, success, expectation of success, and desire for further participation. The items used in this index were numbered 1-8, 12, and 13 in the questionnaire, and were scored on a 5-point Likert-type scale, with values of 5 being the highest SCI and values of 1 being the lowest. I averaged participants' responses to these items to create their Social Closeness Index score (SCI). In order to determine internal consistency and reliability of these measures, I calculated Cronbach's alpha (α) for both pre-test and post-test. This resulted in values of 0.87 for the pre-test, and 0.84 for the post-test, indicating a high degree of internal reliability (Cronbach, 1951). Interestingly, the Cronbach's α values are higher than that found in the original study ($\alpha = 0.76$)

Across the full sample of participants SCI scores for the pre-test ranged from 1.9 to 5. Scores from the post-test ranged from 1 to 4.5. This range comparison shows that there was an overall drop in social closeness scores after the introduction of asynchrony. Descriptive statistics (means and standard deviations, in points), and effect sizes of SCI scores were calculated for all participants then divided by group (Table 4.1). In the pre-test, standard deviations are under a point for each group, suggesting the scores were relatively consistent and had little variation.

Post-test standard deviations are larger, suggesting the impacts of asynchrony were more variable, especially in the novice, intermediate, and advanced groups.

Table 4.1

Descriptive Data from Social Closeness Index Scores by Group

	Pre-test		Post-Test		
Group	*M*	*SD*	*M*	*SD*	Cohen's *d*
All (N=163)	3.893	0.889	2.618	1.286	1.15
Beginner (N=17)	3.682	0.917	3.488	1.013	0.2
Novice (N=46)	3.950	0.847	2.518	1.288	1.43
Intermediate (N=54)	3.887	0.861	2.594	1.275	1.19
Advanced (N=46)	3.920	0.940	2.554	1.249	1.24

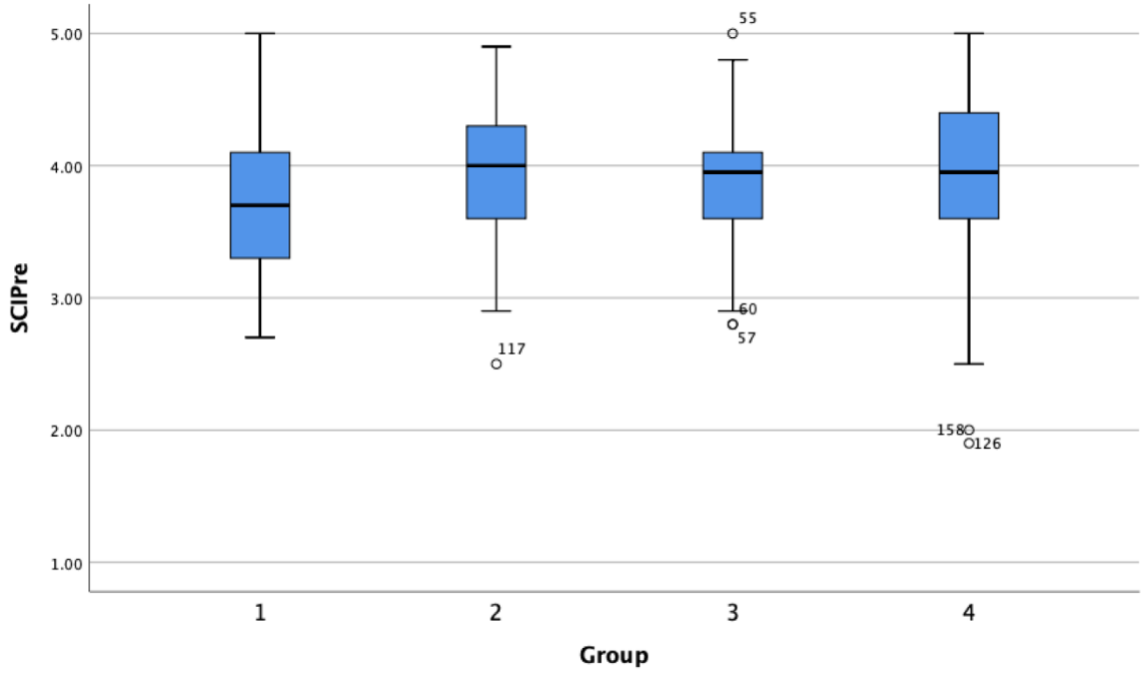
Note. Means and standard deviations listed in points.

To determine if observed differences in mean SCI scores demonstrated a reduction in feelings of social closeness as a result of audio-visual asynchrony across all groups, I conducted a within-subjects ANOVA using pre-test and post-test SCI values as the repeated measure, and group as the independent variable. Follow up paired t-tests with a Bonferroni correction to control Type I error for familywise comparisons were employed in order to determine group differences at the pre-test level and at the post-test level. Omnibus results of the ANOVA indicated group differences are present, $F(3, 159) = 14.97$, $p < 0.001$, $\omega_2 = 0.049$. The effect size was small; only 5% of variation across all pre- and post-test measures is explained by group membership when viewed together.

An examination of a pre-test ANOVA shows the observed pre-test means are all similar, demonstrating there were no significant differences between groups at the pre-test (baseline) $F(3, 159) = 0.94$, $p = 0.42$, $\omega_2 = 0.001$ (See Figure 4.1).

Figure 4.1

Pre-test Social Closeness Index Scores in Points (Means, Standard Deviation, Range) by Group



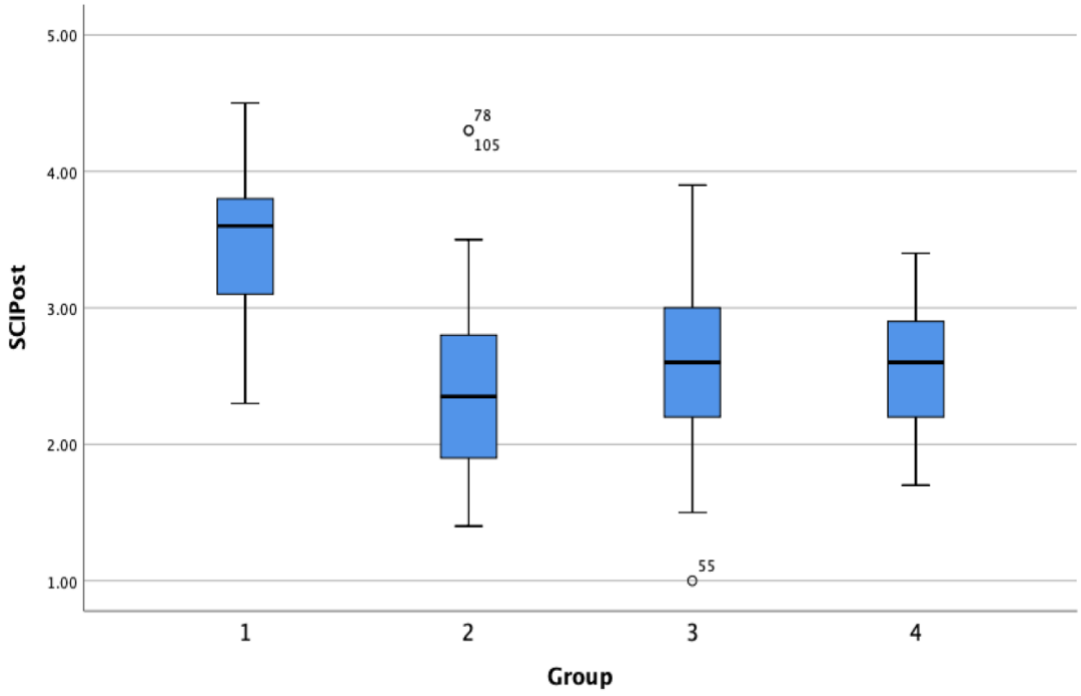
Note: Group 1 = Beginner, Group 2 = Novice, Group 3 = Intermediate, Group 4 = Advanced. Outliers indicated in circles by participant number.

Post-test ANOVA indicated significant group differences on the post-test SCI scores, $F(3, 159) = 14.69$, $p < 0.001$, $\omega_2 = 0.201$. This was a large effect size, meaning 20% of the variation in post-test SCI scores is explained by group membership. Post-hoc comparisons with Bonferroni correction for familywise Type I error were then completed to determine group differences. Results of post-hoc tests suggest the introduction of audio-visual asynchrony did not disrupt feelings of social closeness within the beginner ensemble. The novice, intermediate, and advanced ensembles, however, do show considerable drops in SCI scores from pre-test to post-test, but, interestingly, do not markedly differ from each other (See Figure 4.2). This result may

indicate group membership and years of experience may ultimately influence the response to audio-visual asynchrony and resulting feelings of social closeness.

Figure 4.2

Post-test Social Closeness Index Scores in Points (Means, Standard Deviation, Range) by Group



Note: Group 1 = Beginner, Group 2 = Novice, Group 3 = Intermediate, Group 4 = Advanced. Outliers indicated in circles by participant number.

Analysis by Item. In order to explore the component aspects of the SCI in an effort to understand the deeper nuances of group responses, I examined each item of the SCI on its own. Due to the limitations of Likert-type items, comparing results on a one-item level violates the assumptions required for parametrical statistical analysis. As such, descriptive statistics including means, standard deviations, and effect size will be used to inform a more qualitative discussion of observed differences. See Tables 4.2, 4.3, and 4.4 for complete descriptive statistics by item.

Table 4.2

Social Closeness Index Scores by Item and Group, Pre- and Post-test Comparison (Beginner and Novice groups)

	Beginner				Novice			
	Pre-test		Post-test		Pre-test		Post-test	
Question	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
1	2.88	1.08	3.06	0.94	3.63	0.89	1.86	1.02
2	3.59	0.77	3.24	0.64	3.79	0.70	2.28	1.09
3	4.18	0.38	4.29	0.57	4.19	0.72	3.26	1.16
4	3.82	0.62	3.94	0.87	3.63	0.86	2.95	1.16
5	3.65	0.76	3.00	0.84	4.28	0.79	1.91	0.86
6	3.53	0.78	3.06	1.06	4.12	0.72	2.05	0.81
7	3.24	0.94	3.82	0.86	3.63	0.81	4.30	0.82
8	3.53	0.78	2.88	1.02	4.16	0.78	1.60	0.81
12	4.06	0.94	3.76	1.00	4.14	0.73	1.81	0.95
13	4.35	0.90	3.76	1.00	4.42	0.72	1.70	0.98

Note. Means and standard deviations listed in points.

Table 4.3

Social Closeness Index Scores by Item and Group, Pre- and Post-test Comparison (Intermediate and Advanced groups)

	Intermediate				Advanced			
	Pre-test		Post-test		Pre-test		Post-test	
Question	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
1	3.35	0.86	2.22	1.03	3.50	0.90	2.37	1.05
2	3.61	0.80	2.67	1.15	3.70	0.80	2.65	0.81
3	4.19	0.67	3.50	1.05	4.13	0.80	3.63	0.84
4	3.41	0.93	3.15	1.13	3.70	0.98	3.33	1.16
5	4.06	0.62	2.04	0.86	4.28	0.83	1.93	0.84
6	4.00	0.61	2.00	0.79	4.00	0.86	1.96	0.86
7	3.81	0.86	4.19	0.90	3.91	0.88	4.35	0.91
8	3.94	0.91	1.72	0.97	3.96	0.93	1.54	0.71
12	4.07	0.84	2.57	1.27	3.80	0.97	1.98	0.77
13	4.43	0.78	1.89	1.07	4.22	1.10	1.80	0.85

Note. Means and standard deviations listed in points.

Table 4.4

Effect Size by Item, Total Sample

Question	*Cohen's d*
1	1.11
2	1.51
3	0.69
4	0.33
5	2.42
6	2.22
7	0.57
8	2.37
12	1.61
13	2.27

Note. 0.2-0.5 = medium, 0.51-0.8 = large, > 0.8 = very large (Cohen, 1988).

Question 1. This question examined the construct of inclusion of self in other by using a series of colored circles in various levels of overlap. Each set of circles was given a number on the 5-point scale, with the circles not touching at all as 1 and the fully overlapped circles as 5. The total population (N = 163) mean score pre-test was 3.40 points with a standard deviation of 0.94 points. The mean post-test score was 2.26 points with a standard deviation of 1.10 points. This means the total sample population had a considerable difference in their concept of inclusion of self in other and the effect size was large. In this case, we can see that the mean values decreased, suggesting that the addition of audio-visual asynchrony negatively interfered with the construct of inclusion of self in other. Interestingly, the pre-test mean value was only slightly over 3, which is the mid-point of the scale. This picture had the circles overlapping by 25% and indicates some sense of closeness and inclusion of self in other, but not to the point of intimacy (full inclusion of self in other).

An interesting result of the analysis by group shows the beginner group's (N = 17) mean scores actually *increased* from pre- to post-test (M_{pre} = 2.88, SD = 1.07; M_{post} = 3.06, SD =

0.94). Although the difference in scores is small, it does demonstrate two things: the first being that this group did not feel particularly close to each other at the onset of the study, and secondly, the shared experience of the experiment, or simply just the opportunity to run the piece two more times, helped players to feel more connected. The novice, intermediate, and advanced groups all markedly decreased in the construct of inclusion of self in other.

Question 2. This question asked how connected participants felt to others in the group, a measure of feelings of social closeness. Similar to the result of question 1, the overall population had a significant drop in scores (M_{pre} = 3.67, SD = 0.79; M_{post} = 2.63, SD = 1.05; d = 1.51), again suggesting the introduction of visual asynchrony disrupts connection between members of the ensemble. When examined by group, the beginner group did not have a significant difference between scores but did record a very slight drop in mean score (M_{pre} = 3.59, SD = 0.77; M_{post} = 3.24, SD = 0.64). The novice, intermediate, and advanced groups dropped by approximately one point each (3.7 to 2.65 points) between pre- and post-test.

Question 3. This question asked how likeable the other participants in the ensemble were. Although similar to question 2, this question adds in a level of emotion and shifts the focus from self to opinions of others. The results suggest that visual asynchrony does in fact make people less likeable (M_{pre} = 4.16, SD = 0.70; M_{post} = 3.55, SD = 1.04; d = 0.69) but the effect was moderate. Interestingly, the advanced group did not demonstrate the same level of reduction in likeability (M_{pre} = 4.13, SD = 0.80; M_{post} = 3.63, SD = 0.84) from that of the intermediate and novice bands. However, as in question 1, the beginner group's scores increased from pre- to post-test (M_{pre} = 4.18, SD = 0.38; M_{post} = 4.29, SD = 0.57), but only slightly.

Question 4. In this question, participants were asked the extent to which they feel similar to the other members of the ensemble. The novice group recorded the largest drop in feelings of

similarity, but by less than a point (M_{pre} = 3.62, SD = 0.86; M_{post} = 2.95, SD = 1.16). The beginner group slightly increased in feelings of similarity (M_{pre} = 3.82, SD = 0.62; M_{post} = 3.94, SD = 0.87), while the intermediate and advanced groups slightly decreased in feelings of similarity (B: M_{pre} = 3.40, SD = 0.93; M_{post} = 3.15, SD = 1.13. D: M_{pre} = 3.70, SD = 0.98; M_{post} = 3.32, SD = 1.16).

Questions 5 and 6. These questions asked about participant's success in synchronizing with the conductor and the rest of the ensemble. Across the board, SCI values plummeted between pre- and post-test in regard to success in synchronizing with the conductor (Pop: M_{pre} = 4.12, SD = 0.78; M_{post} = 2.07, SD = 0.91; d = 2.42) and the ensemble (Pop: M_{pre} = 3.97, SD = 0.76; M_{post} = 2.11, SD = 0.91; d = 2.22). This suggests both an awareness of the different streams of sensory information and an awareness of when they become jumbled. This result also implies an understanding of the "social contract" between ensemble musicians to play together under the guidance of the conductor. The group differences were most pronounced in the novice and advanced groups, each having identical mean values of 4.28 points (pre-test) and 1.90 points (post-test) (SDs 0.79/0.86 and 0.83/0.84 respectively). The beginner group did not significantly change in feelings of success in synchronization with the conductor or ensemble (Q5: M_{pre} = 3.65, SD = 0.76; M_{post} = 3.00, SD = 0.84; Q6: M_{pre} = 3.53, SD = 0.78; M_{post} = 3.06, SD = 1.06).

Questions 7 and 8. These two questions function like a mini set of pre- and post-test questions. In these questions, participants are asked to rate their expectation of synchrony before they started, and how well that expectation was met. As such, comparisons of questions 7 and 8 are done as a pair within the pre-test, and again within the post-test, rather than horizontally comparing item 7 pre- to item 7 post- as done with the other questions. Interestingly, overall group expectations for synchronous performance were somewhat moderate at the outset of

rehearsal (Q7: M_{pre} = 3.72, SD = 0.89) and participants seemed to be generally pleased with their performances in the control condition (Q8: M_{pre} = 3.94, SD = 0.90). This pleasant result had a noticeable impact on the expectations for synchrony in the treatment condition. Participants had higher expectations for synchrony after completing the control condition, which is clearly reflected in the Q7 post-test scores (M_{post} = 4.23, SD = 0.89; d = 0.57). This expectation was shattered by the experiment (again, as expected, but not without a considerable outburst of emotion from the participants—everything from outright laughter, to nervous twittering, verbal outbursts of frustration, and strongly disapproving glares) and significantly demonstrated in Q8 post-test values (M_{post} = 1.76, SD = 0.95; d = 2.37). The advanced group showed the greatest difference between expectations in the post-test (Q7: M_{post} = 4.34, SD = 0.91; Q8: M_{post} = 1.54, SD = 0.71).

Questions 12 and 13. These two questions explore the effects of positive ritual interactions. Question 12 is a simple ranking of "how enjoyable was this experience." Question 13 asked participants to consider future intentions for participation based on whether the rehearsal experience was "the norm" (referring to the rehearsal condition the participants just experienced). Notably, the beginner group did not have a significant decline in enjoyment or desire to participate, even though their mean scores did drop slightly from pre- to post-test (Q12: M_{pre} = 4.06, SD = 0.94; M_{post} = 3.76, SD = 1.00. Q13: M_{pre} = 4.35, SD = 0.90; M_{post} = 3.76, SD = 1.00). These values are still comfortably in the realm of positive enjoyment and continued participation. The novice, intermediate and advanced groups indicated a likelihood to essentially mutiny and walk out if rehearsals had the level of asynchrony found in this experiment, with large, significant drops in mean scores from pre-test to post-test on both questions(Q12 Novice: M_{pre} = 4.14, SD = 0.73; M_{post} = 1.81, SD = 0.95. Q13: M_{pre} = 4.42, SD = 0.72; M_{post} = 1.70, SD =

0.98. Q12 Intermediate: M_{pre} = 4.07, SD = 0.84; M_{post} = 2.57, SD = 1.27. Q13: M_{pre} = 4.43, SD = 0.78; M_{post} = 1.89, SD = 1.07. Q12 Advanced: M_{pre} = 3.80, SD = 0.97; M_{post} = 1.98, SD = 0.77. Q13: M_{pre} = 4.22, SD = 1.10; M_{post} = 1.80, SD = 0.85).

The Experience Factor. In light of the differences that emerged between groups in the above comparisons of means, particularly the consistent exclusion of the beginner group from statistical significance in SCI item comparison, I chose to explore the predictive effects of experience on Social Index Score while controlling group membership. In order to do this, I completed a multiple linear regression with sequential predictor entry. Sequential predictor entry specifically allows for testing incremental variance accounted for as predictors are added to the model. For this analysis, the dependent variable was the post-test SCI scores, Block 1 was the pre-test SCI scores, and block 2 was standardized years experience. Results showed that pre-test SCI scores alone did not account for significant variation, R^2 = 0.01 ($R^2_{adjusted}$ < 0.01), $F(1, 140) = 1.54$, $p = 0.217$. The addition of years experience into the model also did not result in a significant change in SCI scores, (R^2_{change} = 0.01, $F_{change}(1, 139) = 1.24$, $p = 0.267$), and suggests that difference in SCI scores is influenced by more than experience alone.

To confirm this finding, I added a third block to the regression analysis. This block consisted of group membership. Group membership was dummy coded (0 and 1, with 1 being membership in that group). Results of this analysis did account for significant change in variation, (R^2_{change} = 0.25, $F_{change}(3, 136) = 15.56$, $p < 0.001$), confirming the findings of the ANOVA. The average SCI post-test score was 2.83 points (SE = 0.37), holding all other variables constant, $t(136) = 7.75$, $p < 0.001$. Participants in the intermediate group had an estimated drop in SCI scores of 1.00 points from that of the beginner group, b = -1.00, SE = 0.18, $t(136) = -5.51$, $p < 0.001$, while participants in the novice and advanced groups saw an estimated

drop in SCI scores of 1.17 and 1.15 points respectively, b = -1.17, SE = 0.18, $t(136)$ = -6.70, $p < 0.001$; b = -1.15, SE = 0.23, $t(136)$ = -5.09, $p < 0.001$.

Follow up paired *t*-tests with a Bonferroni correction indicated the novice, intermediate, and advanced groups did not significantly vary from each other, however each had markedly lower SCI scores from the beginner group (Beginner-Intermediate: M = -0.23, SD = 0.62, $t(162) = -4.66$, $p < 0.001$. Beginner-Novice/Beginner-Advanced: M = -0.18, SD = 0.60, $t(162) = -3.80$, $p < 0.001$). These findings suggest an interpersonal/cognitive awareness threshold exists between beginner and non-beginner ensembles.

Analysis of Interpersonal Challenges. These three questions focused on challenges to interpersonal closeness including difficulty, feelings of embarrassment, and the focus of blame. I calculated descriptive statistics which included means and standard deviations. For each question I also calculated the effect size using Cohen's *d* in order to further understand the magnitude of the differences between pre- and post-test. In order to guarantee internal consistency and reliability of these measures, I also calculated Cronbach's alpha for both pre-test and post-test. This resulted in values of 0.76 for the pre-test, and 0.70 for the post-test, indicating a good degree of internal reliability (Cronbach, 1951). Complete mean comparison results are shown in Table 4.5, 4.6, and 4.7.

Table 4.5

Interpersonal Challenge Scores by Item, Beginner and Novice Groups

	Beginner				Novice			
	Pre-test		Post-test		Pre-test		Post-test	
Question	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
9	1.94	1.00	2.59	1.09	1.49	0.69	3.95	1.29
10	2.06	1.26	2.06	1.06	1.33	0.71	3.23	1.38
11	2.35	0.84	2.82	1.10	2.53	0.90	3.33	1.27

Note: Means and standard deviations listed in points.

Table 4.6

Interpersonal Challenge Scores by Item, Intermediate and Advanced Groups

	Intermediate				Advanced			
	Pre-test		Post-test		Pre-test		Post-test	
Question	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
9	1.69	1.05	3.63	1.06	1.37	0.79	4.02	1.01
10	1.43	0.74	2.54	1.23	1.33	0.72	2.61	1.15
11	2.43	1.03	3.15	0.95	2.43	0.99	3.11	1.24

Note: Means and standard deviations listed in points.

Table 4.7

Effect Size by Item, Total Sample

Question	*Cohen's d*
9	1.94
10	1.13
11	0.68

Note: 0.2-0.5 = medium, 0.51-0.8 = large, > 0.8 = very large (Cohen, 1988).

Questions 9 and 10. These two questions looked at interpersonal challenges of ensemble performance, specifically perceived difficulty and feelings of embarrassment. For these items, low values are viewed more positively (1 = not at all/5 = very much). When examined by group,

the beginner group only suffered slight differences in feelings of difficulty or discomfort due to the asynchronous nature of the task (M_{pre} = 1.94, SD = 1.00; M_{post} = 2.59, SD = 1.09). Interestingly, the mean values for Q10 were identical (M = 2.06 points) suggesting that feelings of embarrassment were not affected by the introduction of audio-visual asynchrony.

The novice, intermediate, and advanced groups demonstrated large, significant increases in the perception of difficulty (Q9), suggesting visual components of sensory input are relied upon heavily in this environment and visual asynchrony/ incongruence is highly deleterious (Novice: M_{pre} = 1.49, SD = 0.69; M_{post} = 3.95, SD = 1.29. Intermediate: M_{pre} = 1.69, SD = 1.05; M_{post} = 3.63, SD = 1.06. Advanced: M_{pre} = 1.37, SD = 0.79; M_{post} = 4.02, SD = 1.01). Feelings of embarrassment also significantly increased in these groups although mean scores did not cross the midline of the scale (i.e., staying on the more benign, "not at all" side) (Novice: M_{pre} = 1.33, SD = 0.71; M_{post} = 2.23, SD = 1.38. Intermediate: M_{pre} = 1.43, SD = 0.74; M_{post} = 2.53, SD = 1.23. Advanced: M_{pre} = 1.32, SD = 0.72; M_{post} = 2.61, SD = 1.15).

Question 11. Question 11 specifically focused on who was to blame for mistakes made during the rehearsal and is designed to shed light into both the level of critical self-awareness of the participant and their overall awareness of the group. This question was structured in a 5-point scale with 1 = me and 5 = others. At a group level, the intermediate band showed the largest shift in blame toward others (B: M_{pre} = 2.43, SD = 1.03; M_{post} = 3.15, SD = 0.95), while the beginner, novice and advanced bands showed minor shifts in blame (A: M_{pre} = 2.35, SD = 0.84; M_{post} = 2.82, SD = 1.10. C: M_{pre} = 2.53, SD = 0.90; M_{post} = 3.33, SD = 1.27. D: M_{pre} = 2.43, SD = 0.99; M_{post} = 3.10, SD = 1.24).

Qualitative Analysis

The final item of the questionnaire was an open-ended response to how participants felt during the rehearsal. All responses were considered valid, meaning no responses were excluded. First, I transcribed all responses into an Excel spreadsheet organized by participant number and pre-test/post-test. Then I marked frequency of response phrases and words. From there I grouped similar responses into categories, and from those categories I created themes. Coding was independently verified by a non-participant scholar with background in ensemble music performance and music-education, with 93% agreement.

Pre-test Responses. This part of the study functioned to establish a baseline for the emotional state of the participant. As if we were beginning a typical rehearsal, we played through the chorale twice with me conducting. I ensured my conducting gesture was clear, predictive, and in line with the tacit expectations of the music (i.e., steady, moderate pace, breaths every phrase). Instructions to the group were general and did not suggest a course of attention (i.e., I did not tell them to listen to each other and play together; I merely raised my arms and invited them to play). Pre-test responses were generally positive and indicated an overarching sense of belonging, comfort, and connectedness.

The first pre-test theme is that of ***Positive Emotional Affect***. Participants described their emotions during the pre-test rehearsal as being happy, comfortable, relaxed, calm, contented, and experiencing a feeling of energy and enjoyment. These general comments tended to be evenly distributed across all groups. Some participants remarked, "it felt like a regular rehearsal" (B19-male, 21, saxophone; D20-undisclosed), and "happy, musical; I always have a great evening at band rehearsal" (B31-female, 27, saxophone), "excited to be here" (B39-female, 29, flute), "[I] enjoyed the experience very much" (A4-male 76, saxophone), and "a good start to band night"

(C38-female, 61, clarinet). Some participants indicated particularly strong feelings of pleasure, such as C3, a 73-year old female, who said, "[I feel] uplifted, joy, happy, moved through music," B3, a 65-year old clarinet player, who stated "rehearsals and music are my escape from the rest of my day. So, I felt great, as I always do at rehearsal, playing music," and B26, a 55-year old male trumpet player, who said, "I love playing music. This is a great way to relax and unwind. Take your mind off the day's work." These positive emotions are summed up beautifully by 40-year old female saxophonist, participant B17, who stated, "It was a chore to get out of the house but now that I'm here I'm so happy to be doing this :) Rewarding, accomplishment, win, I matter."

***Personal Awareness*.** This second theme centers on comments that had to do specifically with personal achievement or feelings. Interestingly, personal awareness statements tended to the negative, suggesting that when participants were focused on themselves, they were viewing their performance experience in a critical manner. General statements include feelings of confidence (or lack thereof) in personal skill, acknowledgement of errors, statements of anxiety and feelings of nervousness to sight-read, and varying levels of mental engagement. Non-binary clarinetist, C2, remarked they felt "anxious at start then relieved as we learned the song," and A3, a 58-year old flautist, stated, "I felt unprepared. I wished I could have heard how the chorale was supposed to sound. I think we did ok though, considering" This sentiment was echoed by participant B46, a 31-year old female euphonium player, who felt "unfocused and unprepared," and participants B6 (female, 61, oboe) and B8 (female, 45, clarinet) who indicated feelings of "nervous," and "tension and concern for intonation" which resulted in "over-compensating" the first time through the chorale. Both participants indicated the second time through was better for them and they felt confident and pleased. The sentiment of repetition being positive was also stated by 65-

year old male trombone player, B41, “Going through the piece 2x was great. Good confidence builder.” C9 (female, 35, clarinet) indicated she was not warmed up and felt like she did not have enough air so intonation and air support was poor, and C42(male, 31, flute) remarked “[I was] occasionally frustrated by my silly mistakes. Mentally engaged. Attempting to track variables of my own performance, conductor, and the rest of the band.” Participant C46, a 67-year old female clarinetist, indicated frustration over her own performance, stating, “I played several wrong notes and got behind. Frustrated because I should be able to play better.” Participant A5, also a female clarinetist, was mortified over “the squeak.”

A sub-set of personal awareness comments centered on the self in context of the whole. I’ve intentionally kept these separate from the next theme of social awareness as these comments are inherently different. They speak to specific feelings on a personal level yet demonstrate an awareness of the ensemble context. Examples of this include, “self-conscious of tuning, interested to hear other parts” (D38-female, 53, flute), “I don't like chorales so was a challenge to pay attention and care” (D11-female, 61, french horn), “[I was] focused on my part; little awareness of other players” (D8-female, 53, clarinet), “I played the notes. Focusing on playing the notes and not listening to others” (C12-female, 59, oboe), “some pressure to be a leader/example to other members in the section/ensemble. They rely on me” (B13-male 29, french horn), and “I felt a little anxious going in since I am out of practice, but everyone is nice and no one is there to make anyone feel bad” (A13-female, 31, flute).

In contrast, there were some comments that seemed to indicate an absolution of individual fault by blaming mistakes on the ensemble. “I played a few wrong notes but heard wrong notes in other parts” (C1-male, 61, bassoon), “My previous training is to play over the bars but everybody here seems to breathe together at the same time so in a slow piece like this it

was a bit awkward" (C9-female, 35, clarinet), and "my section was in synch but one of the other sections was playing too fast at the start" (C40-male, 25, trombone).

Social Awareness. Pre-test comments that centered on social or ensemble awareness were abundant. They speak of feelings of connectedness, belonging, support from each other and the conductor, and an awareness of the other members and parts of the ensemble. These are illustrated by comments such as "comfortable, enjoyable to do a simple chorale with other musicians" (D18-female, 69, trumpet), "things felt harmonious. Felt engaged to listen to what others were playing" (D36-female, 37, euphonium), "simple, easy tune. Felt like a team with each doing their part" (D15-female, 30, trombone), "supported; not singled out," (D10-female, 60, french horn), "I liked that I could synchronize with other members" (C45-male, 60, clarinet), "I felt in harmony with the rest of the ensemble" (C37-female 39, tuba), "comfortable with the beginner group and conductor" (B48-male, 55, trombone), "everyone was on the same page and I was contributing to the greater whole" (B22-male, 29, trumpet), and "I felt relaxed and comfortable playing with other members. The conductor made the experience comfortable" (A2-female, 57, clarinet). A particularly powerful comment was made by participant C11, a 61-year old female flute player, who stated "I enjoy playing with this group. I feel supported and encouraged to learn. I travel a fair distance to come to play with this group each week. I feel like I belong."

There were some particularly interesting comments about the ensemble environment itself. 66-year old female clarinetist, B12, stated "connectedness/synchro/difficulty depends on where one sits in the ensemble – re: ability of neighbouring players," which suggests that overall experiences can be both positively and negatively impacted by the relative skill levels of the people in the immediate environment. C32, a 61-year old female flute player, implies the audio

environment seems to influence feelings of social connection even though the awareness of the full ensemble remained present. She stated, “[I] felt more connected with my section and those near me than the whole ensemble.” This is echoed by D17, also a female flute player, who “couldn't hear others on my part so felt alone. Felt competent and confident. Overall I enjoyed the chorale sound of this group.”

The familiarity of the ensemble and environment seemed to contribute positively to feelings of social closeness. This sentiment is illustrated in comments such as “we are used to playing together. I enjoyed the simplicity and doing it together,” (C39-male, 51, clarinet), “comfortable with familiar circumstances” (C25-male, 61, trumpet), and “comfortable with the beginner group and conductor” (B48-male, 53, trombone). Comments that suggest familiarity and perhaps a sense of skepticism on the prospects of musical success come from participants C23, a 55-year old female trumpet player, and C14 , a 61-year old female flautist, who were “interested to hear how we would sound together,” and “delightfully surprised at the beautiful sound we created together.” These two observations come from members of Group C, the novice band, and indicate an understanding and acceptance of the lower collective skill level but did not seem to impact the feelings of social closeness and affinity for the other members of the ensemble. This notion of being part of a novice band and acceptance of inherent challenges of such an ensemble, does not seem to have an adverse effect on feelings of belonging or closeness; if anything, the shared experience of working through the music and hearing improvement promotes feelings of pleasure and connection. C30, a 67-year old non-binary clarinetist, articulates this concept clearly: “it felt good to hear the progression from first time to second time. The sound improving in togetherness was very satisfying.”

***Valence and Influence of Role and Group Membership*.** The final two pre-test themes are somewhat broader than the previous themes in that they look at the tone of responses as well as any trends within groups. Overall, the valence, or intensity of emotion, of the pre-test comments was relatively neutral. This means that participants were not particularly "ramped up" or disengaged from the task. As this experiment was conducted at the beginning of each group's regular rehearsal block, the emotional valence of the members should be reflective of how they were feeling in that moment and indicative of their feelings toward rehearsals in general. There were indications of positive high valence, as demonstrated in vocabulary such as excited, fun, highly enjoyable, engaged, and happy. Indications of negative high valence were also present and seemed to arise from individual responses to the unknown (i.e., change in routine) or to the chorale itself. These were demonstrated with comments such as bored, too easy, not sufficiently challenged, a little panic, anxious and nervous. Particularly poignant comments were made by horn player, D11: "I don't like chorales so was a challenge to pay attention and care" and 37-year old female clarinetist, D14: "good piece but boring. Don't want to continue with this." Moderate to banal valence comments included words such as comfortable, relaxed, ready to participate, ordinary, pleasant, okay, fine, and "neutral."

Group membership did seem to have trends within their pre-test responses. The beginner ensemble (Mean years experience = 1.53), generally expressed feelings of individual anxiousness and anticipation but were happy and comfortable with each other. They felt safe to play, even though they expected mistakes—"the first time reading through a piece is never perfect but I think we did well" (A6-female, 26, clarinet)—and trusted that everyone was at a similar level and would not be subject to judgement. This is summed up nicely by flautist, A13, who said, "everyone is nice and no one is there to make anyone feel bad."

The novice ensemble (Mean years experience = 6.81) seemed to demonstrate a particularly strong connection with each other. There were multiple comments like “I feel like I belong” (C26, undisclosed), “In harmony with the rest of the band” (C37-female, 39, tuba), “we are used to playing together” (C39-male, 51, clarinet), “comfortable with the ensemble” (C44-female, 48, clarinet), and “I liked that I could synchronize with the other members” (C45-male, 60, clarinet). Members of Group C were overall quite relaxed and comfortable, and the familiarity of the environment seemed to ease anxiety. Other comments tended toward an individual focus and a willingness to learn and improve, such as comments about initial mistakes— “occasionally frustrated by my silly mistakes. Mentally engaged. Attempting to track variables of my own performance, conductor, and the rest of the band” (C42-male, 31, flute)—discussing mistakes with section-mates and feeling better after the second read-through as illustrated by C35 (female, 59, euphonium), “tentative initially. Was trying to listen for other instrument groups, listening for phrases. Second time was better. Discussed error with band mate.”

The intermediate ensemble (Mean years experience = 17.33) was generally quite calm and comfortable. They tended to the cerebral in their observations, making comments such as curious and focused, that playing a different part than usual was an interesting experience (B9-female, 64, clarinet), and one particularly delightful response from B32, a 27-year old female saxophone player: “I wonder if this study is centrally for groups who are familiar with each other as groups that are unfamiliar. I'm curious about methodology.” Equally, this group, particularly the saxophone section, had the most specific comments of all the groups about band night being an escape from their regular lives. “I love playing music. This is a great way to relax and unwind. Take your mind off the day's work” (B26-male, 55, trumpet), “It was a chore to get out

of the house but now that I'm here I'm so happy to be doing this :) Rewarding, accomplishment, win, I matter" (B17-female, 40, saxophone), "happy, musical, I always have a great evening at band rehearsal" (B31-female, 45, saxophone), and "rehearsals and music are my escape from the rest of my day. So, I felt great, as I always do at rehearsal, playing music" (B33-male, 61, saxophone).

The advanced ensemble (Mean years experience = 32.71) was able to complete the control task virtually flawlessly. As such, the comments from this group were ones of pleasure and contentment, connection and personal value: "cohesive, calm, a sense of community, confident" (D45-male, 34, tuba), "Secure, satisfied, comfortable" (D16-female, 75, french horn), "accepted" (D27-male, 48, euphonium) and "respected" (D32-undisclosed). There was ease with the simplicity of the task as illustrated by D18 (female, 69, trumpet) and D25 (undisclosed) who remarked it was "enjoyable to do a simple chorale with other musicians," and "the music was straight forward and we played it well." D15, a 30-year old female trombonist, commented "[It was a] simple, easy tune. Felt like a team with each doing their part," which was echoed by 37-year old female euphonium player, D36, who said "things felt harmonious. Felt engaged to listen to what others were playing."

Interestingly, and specific to this group, there was a level of distaste for the simplicity of the task as illustrated by D43, a 26-year old male tuba player who was "having fun, a little disengaged by the easy music but got an opportunity to listen around the ensemble," D14 (female, 37, clarinet) "good piece but boring. Don't want to continue with this," and D11 (female, 61, french horn), who firmly stated "I don't like chorales so was a challenge to pay attention and care."

Although the advanced group did feel connected to each other, they were certainly critical of the pre-test performance. This is well illustrated by D1, a 34-year old female clarinetist who "felt quite connected to the other players and conductor. Wasn't a polished rehearsal but with a few more run-throughs it would have been solid," and D24, a 37-year old female saxophonist who stated, "the second round had a slightly better responsiveness, but I didn't feel we reached the level of emotional commitment and artistry that this group is capable of."

Post-test Responses. The post-test questionnaire was completed after the treatment stimulus. Like the pre-test, the ensemble played through the chorale twice with me conducting. In this case, however, my conducting was varied in tempo, unpredictable, and unrelated to tacit expectations of the music (i.e., stopped beats, uneven pace, extra-long or absent breaths every phrase). Instructions to the group were general and did not suggest a course of attention (i.e., I did not tell them to listen to each other and play together; I merely raised my arms and began in typical rehearsal manner, saying, "Let's try that again."). The groups all struggled significantly with the task, and the sounds that resulted were, in some groups, unrecognizable as the original chorale. Even as the conductor and researcher, I found it difficult to maintain focus and continue to "direct" the groups. Post-test responses were overwhelmingly negative, some to the point of vitriol, and indicated extreme discomfort, disconnectedness from the ensemble and conductor, and the desire to stop the experience.

The first theme that emerged from the post-test was the focus on ***Sound.*** Different from the pre-test where there were no specific comments about the actual audio information, post-test comments frequently made reference to the unpleasant and unmusical sound of the performance. The sound itself had no meaning and was perceived as a source of irritation and frustration. "The music was destroyed," says C5 (female, 70, saxophone). D17 (female, 62, flute) states "this was

musically unsatisfying; would be frustrating in (sic.) an on-going situation," and B2 (female, 21, clarinet) says "It was very jumbled and hectic. The song did not sound as good and it wasn't as much fun." B17, the 40-year old female saxophone player, had a magnificent response that sums up this finding: "Eewwwwwwww! That was painful! Actually? It's like having someone clap off-time to your favourite piece! Painful!!"

Cognitive Load. C31, a 59-year old male trombonist, alludes to the considerable cognitive load of the large ensemble and the challenge that was faced in the asynchronous condition: "it was chaos. As a beginner player I can only concentrate on so many things. Adding changes in the beat made it difficult to play." This was echoed in statements such as "having to watch the conductor was a major distraction" (C35-female, 59, euphonium), "[I was] lost and confused. Totally disjointed from group. Like Grade 7 band all over" (B48-male, 55, trombone), "[it] was frustrating to play and read the music and follow the conductor" (B54-male,73, tuba), and D36 (female, 37, euphonium) who felt the experience was "uncomfortable and confusing. All over the place. Hard to identify who was similar to me. Hard to keep time and follow."

There clearly was an effort to synchronize with each other. This brings us to the recurring, overarching theme of ***Personal Awareness.*** In this case, the inability to synchronize was met with comments of personal failing and a desire to remove themselves from the group or rehearsal situation. Examples of this include "confused that I wasn't paying enough attention; frustrated." "I'm worse than I thought!" (B8-female, 45, clarinet), "I wondered if I was on the wrong piece. I had to ask my colleague what piece we were playing" (B9-female, 64, clarinet), "humbled; I don't catch on as well as I thought" (B11-female,58, clarinet), "oh boy! I felt lost trying to follow the conductor. I should have paid more attention from the start. I assumed playing the second time would be the same as the first time. I was embarrassed. It was

frustrating" (C11-female, 61, flute), "Wanted rehearsal to be over" (C23-female, 55, trumpet), and the succinctly stated, "happy not to do it again" (B35-female, 36, mallets).

Similar to that of the pre-test, a subset of the individually focused comments bridged the theme of social awareness. C25, a 61-year old male trumpet player, was "mildly disturbed at playing troubles" of both himself and the band. One participant, B13 (male, 29, french horn) commented he "felt more pressure to watch [the conductor] and lead the section. Had difficulty listening for other players. Stressful." Other responses suggested a strong sense of self and the individual contribution to the larger group experience, while acknowledging the shared struggles of the ensemble and a sense of solidarity. This is illustrated by D12 (female, 45, trumpet) "I was annoyed. I wanted to play together but couldn't. Was annoyed with myself for sucking and not playing well but others struggled too," and similarly by C46 (female, 67, clarinet) who said she was "frustrated. Didn't play all the notes or played them wrong but felt okay because everyone was having the same problem," and B33 (male, 61, saxophone), who said "Frustrated. But I still love rehearsal time." D15 (female, 30, trombone) was "frustrated, lost. Worried others were judging me. Focused more on not looking bad than making music. It was easier to remember I'm new to the band [this year]" while participant A1 (male, 78, saxophone) said, "I was a little nervous trying to follow the conductor, but [on] hearing other musicians struggle to keep the timing together, I didn't feel as bad."

Social Awareness. The post-test comments reveal two compelling results of the treatment. One was a strong, negative impact on social closeness, and the other, an increase in feelings of social closeness due to shared trauma. General comments such as disjointed and disconnected from the group were common, as were comments such as "not a successful experience musically or socially" (D30-male, 62, trumpet), and "unconnected and at odds with

some of them" (D28-male, 71, trumpet). Participant C39 (male, 51, clarinet) exclaimed, "ouch! I play for togetherness! I felt stressed and disjointed." The disruption to social closeness was summed up very well by participant C9, a 35-year old, female clarinetist: "there was no societal understanding of what was going on. Uncertainty causes anxiety for some and therefore leaves little room for enjoyment. One of the primary joys of music is that incredible feeling of when it comes together. This couldn't happen here."

Interestingly, some members indicated a strong sense of social connection during the treatment condition. These comments focused on listening to others and trying to align with similar parts, as well as feelings of solidarity and safety. "[I was] disconnected from conductor, highly connected to other musicians - connected due to common experience. Relieved to hear laughter" (C44-female, 48, clarinet), "felt caught off-guard by the changes implemented by the conductor, but it forced me to pay better attention and listen more attentively" (D1-female, 34, clarinet), "disjointed from conductor. Listened to other players to assure where I should be" (D8-female, 53, clarinet), "shared experience of being confused helped me to feel closer to the group" (D9-female, 31, french horn), "disconnected from the conductor but connected to the group because we were all struggling together" (D33-undisclosed). Participant D25 (undisclosed) sums up this sentiment by saying, "Oddly enough, I didn't feel disconnected from the group. I felt we were united in our attempt to deal with bad conducting. We did our best to play together."

Blame the Conductor. In large ensemble music, the group is expected to perform in a particular way: in synch with each other, and with each member of the group doing their respective jobs to the best of their ability (Keller, Novembre, & Hove, 2014). A result of this breach of these tacit expectations is increased feelings of blame and a disruption interpersonal closeness (Tarr, Slater, & Cohen, 2018). The results of this study demonstrate blame for this

disruption was directed particularly toward the perceived leader and source of stability, the conductor. For example, as stated by C26 (undisclosed), “the conductor was totally at fault.” There was a myriad of comments that pertained specifically to the impact of the change in visual stimulus on feelings of social closeness. These include, “[It was] stressful not being connected with the conductor. Didn't mind not being connected to group” (D14-female, 37, clarinet), “the disjointed nature of the conducting caused me to focus entirely on the conductor. Was ignoring the rest of the ensemble in order to follow the director” (D31-male, 28, trombone), and, “[I was] frustrated that many players were not following the conductor. Our responsibility is to follow the conductor!” (D38-female, 53, flute).

There was a set of comments that pertained to the function of conducting as an important source of sensory information, and the requirement of a conductor to effectively communicate through gesture. These statements include, “Conducting is something that should be able to be anticipated.” (C32-female, 61, flute), “disconnected and unable to follow. Hard to play musically. Seemed random and artificial like being led by an inexperienced or uncertain conductor” (C18-female, 54, trumpet), “the ensemble was out of control! We didn't know what to expect from the conductor. Each time we played she conducted differently and erratically. Either she quits or I quit!” (C8-female, 70, flute), “Upset. Conductor broke trust with the band” (C2-non-binary, clarinet), “I felt, sitting in the front row, I had the advantage as I could follow the conductor more easily. I focused on following the conductor rather than playing musically” (B42-female, 47, flute), and finally, this fantastic statement by B32 (female, 27, saxophone) “Welp, that answers that question. I wondered why conducting is a thing that takes years of training.”

Valence and Group Membership. As in the pre-test, there were notable differences between the beginner group responses and the rest of the groups. Overwhelmingly in the novice, intermediate, and advanced groups, the emotional valence of the treatment condition was extremely high on the negative side of the spectrum. People described their emotions as "angry," "ticked," "frustrated," "annoyed," "irritated," "confused," "dismayed," and they did not want to continue playing in this asynchronous manner. However, the beginner group demonstrated an equally high valence, but on the positive side. In their case, participants felt closer to each other after the treatment condition. Reasons for this include personal improvement in performance (examples, "I felt a bit more at ease with the piece having practiced it a bit more" (A13-female, 50, clarinet), and "I played it better the second time" (A4-male, 76, saxophone)), and an overall increase in feelings of comfort (examples, "more comfortable and enjoyable this time" (A7-male, 61, saxophone), "didn't have as much problem" (A8-male, 67, trombone), and "I felt more comfortable than the first rehearsal even though I had some trouble following the conductor" (A3-female, 58, flute)).

Qualitative Responses and the Social Closeness Index

Qualitative responses support the changes in SCI scores from pre-test to post-test. On average, pre-test SCI scores were moderately high, reflected in the comments of general positivity and expressed feelings of belonging, comfort, and pleasure. Post-test SCI scores were markedly lower, and the qualitative responses explained why. Participants were flustered and uncomfortable with the asynchrony experienced, and their blame for mistakes shifted from themselves to the others in the group, particularly the conductor. Participants still indicated a willingness to play together, suggesting that even though the SCI score dropped to moderately low as a result of the audio-visual asynchrony, it was not catastrophic.

CHAPTER 5: Discussion and Implications

A key expectation in large music ensembles is for members to synchronize their individual playing with the other members of the group in order to produce a cohesive and meaningful performance (Palmer, 1997). This requires the individual to attend to a complex system of sensory stimuli, anticipate the actions of others and adjust their own performance in order to maintain synchrony (Keller, Novembre, & Hove, 2014). Synchronous movement and joint action generate feelings of group solidarity and belongingness, and promote interpersonal connection (Stupacher, Maes, Wood, & Witte, 2017; Collins, 2004). Unfortunately, synchronous performance does not always occur. Sensory asynchrony occurs when auditory, visual, and kinesthetic information do not align and results in the musician being unable to align their performance with that of others. The inability of an individual to synchronize their movements with other members of the group has been shown to diminish feelings of social closeness and does not promote prosocial behavior (Wiltermuth & Heath, 2009, Stupacher, Wood, & Witte, 2017; Tarr, Launay, & Dunbar, 2016; Tarr, Slater, & Cohen, 2018; Carlson, Berger, & Toivianien, 2019).

The Social Closeness Index

In this study I sought to determine the effects of audio-visual asynchrony on feelings of social closeness in adult community band musicians. The study method was informed by research in music cognition and sociological theory. I asked three questions: (1) Does exposure to asynchrony negatively affect feelings of social closeness and belonging in musicians? (2) Does the violation of the established expectation of synchrony affect feelings of social closeness and belonging? And, (3) does exposure to asynchrony shift mental focus of the performer? The

main measure of this study was the Social Closeness Index. The Social Closeness Index (SCI) is a composite measure that includes the elements of inclusion of self in other, likeability, similarity, connection to others, success, expectation of synchronous performance, and enjoyability. SCI was measured twice, once after a synchronous control condition, and again after the audio-visual asynchrony condition. Through examination of the SCI, I was able to answer the questions posed at the onset of this study.

The observed changes in SCI scores strongly support the conclusion that audio-visual asynchrony negatively affects feelings of social closeness in adult community band musicians (RQ1) and shifts their focus away from each other and toward the self (RQ3). Audio-visual asynchrony seems to disrupt social bonds through the inability to entrain with the ensemble, i.e., participants are unable to attain rhythmic joint action with the other members of the group. As rhythmic joint action requires ensemble musicians to be able to precisely attend to the different sensory information being experienced in real-time and simultaneously adapt their actions in such a way as to maintain synchrony, disruption to auditory and visual information seems to prevent the individual from effective cognitive-motor coordination leaving them unable to achieve interpersonal entrainment. It seems that audio-visual asynchrony essentially shifts the cognitive attention of an ensemble member more toward the self (i.e., becoming highly focused on maintaining their own performance) and away from that of the other, which results in reduced representation and integration of information about self and other (see Keller, Novembre, & Hove, 2014). Feelings of similarity with other members of the ensemble were not affected by the introduction of audio-visual asynchrony, remaining at a moderate level in both pre- and post-test measures. This result gives weight to the idea that adults have a robust sense of self and

recognition of heterogeneity within groups, and feelings of social closeness do not hinge on "being the same" (see Snow, 2001).

An examination of SCI components revealed intact expectations of synchronous performance across groups. Interestingly, there was an increase in scores from pre-test to post-test when participants were asked to rank their expectation of synchronous performance at the onset of each condition—some groups recording an increase of a full point—which indicates participants positively responded to the synchronous control and used it to inform what should happen next. This result provides evidence of ritual chain effects described by Collins (2004), where repeated successful performances seem to magnify the expectation of further synchronous performances and heighten the emotions of the participants. This result also suggests a high level of interpersonal awareness across groups, some level of cognitive understanding of the multi-sensory environment of the wind band (i.e., could evaluate efficacy of actions), and that participants had defined expectations of success related to the shared goal of synchronous performance. This is consistent with the psychological and neuro-cognitive work of Keller, Novembre, and Hove (2014) who describe ensemble musicians as co-performers who work together in "dynamic cooperativity" informed by shared goals and foundational knowledge in order to perform successful rhythmic joint action.

Violation of this expectation of synchronous performance (RQ2) was largely blamed on the conductor. Participants demonstrated focused negativity toward the conductor for [her] role in promoting audio-visual asynchrony. This expectation reinforces the concept of partial symmetry in entrainment (Clayton 2012), where certain sensory information is prioritized due to imbalances in influence. In this case, the conductor, the de-facto leader within a large ensemble, becomes a focused source of visual information and is, by default, considered "correct."

Participants recognized their personal responsibility in maintaining synchrony and their inability to do so, but also expected that the gestural communication coming from the conductor would be informed by the music, congruent to established practices, and provide the player with information on how and when to perform the next notes and phrases (see Hove et al., 2012). When this tacit agreement was violated, it disrupted positive effects on prosocial outcomes and feelings of togetherness (see Tarr et al., 2018).

Participants were highly aware of the stilted and unpredictable conducting gesture and had difficulty in following and adapting their performances. Participants acknowledged the incongruence between the gesture and the expectations presented in the printed music before them. This awareness of where participants could source necessary information (i.e., written, gestural, established performance practice) was demonstrated across all groups, suggesting that participants understood these different informational components and how to interact with them during a rehearsal. As a result, participants were very pointed in their blame of the conductor for not performing [her] role appropriately and not attending to the expectations outlined in the rehearsal.

Social Closeness, Sensory-motor Cognition, and Experience

The disruption of feelings of social closeness by the introduction of audio-visual asynchrony points to the important role of sensory-motor cognition (i.e., how our brains make sense of the visual, auditory, and kinesthetic information experienced during music performance) in the formation of interpersonal bonds. The foundation for interpersonal rhythmic action is entrainment. The brain coordinates movement within the body which allows individuals to align movement with others in a group. This alignment hinges on the ability of the brain to perceive metrical structures and patterns within a piece of music. In this case of audio-visual asynchrony,

participants were faced with unaligned sensory information which prevented the individual from coordinating muscle movements in such a way that allowed for synchronous performance to be achieved. Participants were forced to cope in some manner, using different strategies such as estimating the beat structure (Honisch et al., 2016), the performer adopting the role of leader by assuming responsibility for tempo and adapting less to the partner's irregular timing (Fairhurst, Janata, & Keller, 2014), or selectively blocking or focusing on one stream of information (i.e., ignoring the conductor/only focusing on the conductor) (see Fredrickson, 1994). Evidence for all of these strategies was found in participants' comments such as "I felt I had to lead the section and had difficulty listening for other players," "[I] was guessing where the beat was going to be," "[I] was ignoring the rest of the ensemble in order to follow the conductor," "I focused on following the conductor rather than playing musically," and, "I stopped looking at the conductor and just tried to stay together with the members of my section." These comments support the findings of cognitive researchers and demonstrate that there are multiple ways to navigate asynchrony which are determined by differences in the brain and individual personalities (Keller et al., 2014).

Cognitive-motor skills enable musicians to anticipate, attend, and adapt their performances to that of others and achieve synchronous performance. It seems the ability to predict what's coming and adapt in real-time is of particular importance. In this study, audio-visual asynchrony was achieved through the removal of the predictive aspects of conducting gesture. This disrupted the "cognitive triangle" of anticipation, attention, and adaptation. This aligns with the findings of Desantis and Haggard (2016) who suggest "predicting what sensory outcomes our actions generate may have the important consequence of promoting the temporal unity, or simultaneity, of perceptual experience" (p.2). The inability to predict effectively

resulted in participants being reactive instead of proactive, and, given the natural variability of people's skill and speed in neural processing, the collective ability to synchronize movement was disrupted. This lack of synchrony and inability to entrain resulted in a reduction of feelings of social closeness.

Researchers including Margulis (2014), Palmer (1997), Loehr and Palmer (2011), and Keller and colleagues (2014) found repetition strengthens neural networks, interpersonal awareness, and increases precision of sensory coordination. Even though regression models did not support years of experience as a predictor of SCI scores, it seems some sort of threshold separates the beginner group (all members with < 2 years of experience on their instrument) from all other levels. The beginner group had virtually no differences between pre- and post-test SCI scores, suggesting that they were not negatively affected by audio-visual asynchrony. This may be a result of not being aware of the incongruence between different sensory streams of information, being aware of yet ignoring the asynchrony, or being aware of the asynchrony but being unable to do anything about it. In ensemble music performance, the perceptual experience includes some sort of sound production as the result of the physical action taken to play an instrument in response to a visual cue. Learning the relation between an action and a specific audio-visual outcome drives the cognitive binding of the outcome (Habets, Bruns, & Röder, 2017). The beginner ensemble may simply not have had enough experience to cement these different sensory-motor relationships, and, indeed, still may be at a point of requiring pointed attention to "one thing at a time." As a consequence, the attenuation of audio-visual asynchrony may be due to sensory overload (see Fredrickson, 1994) and the inability to fully integrate multiple sources of information into a single, meaningful package.

It is also possible that members of the beginner group have not developed comprehensive concepts of self-other and as a result, project individual success as group success (i.e., I played better therefore everyone played better). Decety and Sommerville (2003) stated that individuals represent their own and others' goal-directed actions via a single conceptual system and these intentional relation patterns have the capacity to coordinate first-person and third-person information. Indeed, the neurophysiological mechanisms that underpin cognitive-motor skills utilized in ensemble music performance are shaped by experience and enable precise and flexible interpersonal entrainment, as well as the representation and integration of information about self and other within and between individuals' brains (Keller et al., 2014). This concept of projection combined with an awareness of cognitive overload is supported in comments such as "I felt more comfortable the second time;" "I felt a bit more at ease with the piece having practiced it a bit more;" and, "we didn't have as much problem." This projection of individual success as group success can also be extended to the group's overall feelings of social closeness; in many of the component SCI items as well as in participant's open-ended responses, members described an increase in feelings of social closeness and group solidarity. It seems this group strengthened their bonds through a recognition and acceptance of their lack of technical proficiency and the shared experience of ensemble participation.

By SCI element, scores sharply declined in the novice and intermediate groups, with the exception of feelings of similarity. This group effect found in the middle two levels of the ability spectrum of study participants suggests thresholds of tolerance that may be bounded by skill. These groups were the most affected by the introduction of audio-visual asynchrony and were vocal and specific in their displeasure. This may be a response to violating existing concepts of tempo and style for the piece of music used during the study (a 4-part hymn/chorale). Loehr and

Palmer (2011) did find that existing concepts of tempo and style directly influence ensemble synchrony. In this case, prior rehearsal of similar music to that of the study piece, i.e., the typical manner in which a chorale is performed (moderately slow and steady with 4-bar phrases), reinforced the musician's understanding and physical sensation of "how a piece goes." Disruption to this existing construct, coupled with moderate levels of technical skill which prevented the participants from adapting their performances quickly and successfully, likely enhanced the sensation of conflict and contributed to the decline in feelings of social closeness.

The advanced group, although overall negatively impacted by audio-visual asynchrony, seemed to mitigate some of the personal frustrations and performance expectations as a result of a high level of critical awareness and technical ability to quickly adapt their performances to the changes in visual information. Experienced ensemble musicians seem to develop hierarchically arranged internal models that are able to represent events at multiple timescales and to simulate a co-performer's playing style by calibrating to his or her action system (Keller et al., 2014). Moreover, anticipatory mechanisms and adaptive timing may be linked in such a way that allow for interpersonal timing errors to be simulated and corrected in advance. Thus, maintaining alignment and synchronous performance amidst audio-visual asynchrony became a challenge to overcome both as individuals and as a group. Indeed, some members commented on feeling closer to the group after the asynchronous condition, partially as a response to shared experience, but more importantly as a response to the collective will to "solve the problem" and synchronize.

With the introduction of audio-visual synchrony, all groups showed some increase in perception of difficulty, a slight increase in embarrassment, and a shift in blame from self to others suggesting an increase in cognitive load and an attempt to figure out what happened. Again, the beginner group was the least affected by the audio-visual asynchrony, finding the

performance conditions equally difficult and the focus of attention largely on themselves. The novice, intermediate, and advanced groups did experience heightened perception of difficulty and embarrassment, possibly as a result of personal expectations of a certain level of performance and discomfort with the perception of "failure." This was corroborated in the open-ended responses which indicated dismay with personal mistakes, and feelings of anger and frustration as a result of being unable to synchronize effectively with others.

Creating the Opportunity for Social Closeness

Keller, Novembre, and Hove (2014) describe how the interaction of an individual's cognitive-motor skills with their knowledge and goals concerning the task combined with familiarity between co-performers results in effective interpersonal coordination and social outcomes such as interpersonal affiliation and prosocial behaviors. A key component of effective interpersonal coordination and the development of feelings of social closeness is that of a conducive environment for these actions and behaviors to take place. I explored this construct through the use of a baseline measure.

As suggested by Tarr, Slater, and Cohen (2018), the incorporation of a baseline measure of social closeness can help to isolate the effects of synchrony/non-synchrony (p.4). In this study, I used pre-test SCI scores as the baseline measure. The relative strength of the SCI pre-test scores across all groups suggests that participants had existing feelings of social closeness toward other members of the ensemble, and that these feelings were reasons for continued participation in the ensemble. This finding aligns with Collins' (2004) theory of interaction rituals in which ritual joint action promotes group solidarity, feelings of belonging and desire to maintain participation as a way to continuously experience heightened, positive emotions.

Pre-test scores indicated that participants demonstrated an awareness of self-in-other, but not at a level of intimacy, and viewed themselves as members of a heterogeneous population (as shown through moderate scores on similarity and connectedness). This suggests that the individual participants had robust concepts of self, such that they can recognize their individuality while participating in a cohesive group context. An important facet to cohesive group context is the overall likeability of the other members. Pre-test SCI scores across groups were very high, indicating the participants found each other likeable and enjoyed the relationships that developed as a result of participation in the ensemble. This finding is reinforced by participants' comments about feelings of camaraderie, pleasure, comfort, and excitement to participate in rehearsal.

This baseline measure provides a foundation to interpret the findings of the post-test. In the post-test, members of the novice, intermediate, and advanced groups expressed "righteous anger for violations of social ritual" as described by Collins (2004) and suggest a recognition and value placed on the established culture of acceptable behaviors and expectations associated with "band practice." Participants' feelings of social closeness were significantly disrupted as a result of audio-visual asynchrony. Their comments pointed to a combination of exasperation from chaotic sound, confusion with what others were doing, and personal frustration. This suggests the challenges experienced as a result of audio-visual asynchrony, both individual and collective, prevented participants from experiencing the kind of ritual interaction that they came for, leaving them unhappy and disconnected from each other. Participants did state that some asynchrony is to be expected due to the human real-time nature of live music ensemble performance. However, there was a clear understanding that "only so much" would be tolerated and they expected the different members of the ensemble, including the conductor, to acknowledge and take action to

fix it. Given the nature of this study, there was no attempt to correct or mitigate the audio-visual asynchrony which resulted in participants feeling frustrated, confused, and unsure of what to do next. This result underscores the importance of each member of the ensemble, across all roles and parts, to be aware of the others, and to function as engaged co-performers acting toward a clearly communicated common goal.

Social Closeness and Social Distance. The findings of this study focus on the disruptive effects of audio-visual asynchrony on feelings of social closeness in a live rehearsal situation. Given the social reality of Spring 2020, a time where people are required to practice social distancing and self-isolation as a result of a global viral pandemic, the importance of interpersonal connection and physical contact on feelings of wellbeing, belonging, and self-worth has become even more clear. As in-person activities are prohibited at this time, group meetings have been relegated to virtual platforms such as Zoom, FaceTime, Google Hangouts, and Skype as possible. Social rituals such as music rehearsals and performances, festivals, religious gatherings, and sporting events have been cancelled. This disruption to people's usual activities has resulted in an increase of stress and anxiety, loneliness, depression, and reliance on drugs and alcohol (World Health Organization, 2020).

This raises questions on the deeper nature of social closeness. Similar to Goodrich (2019), participants in this study generally indicated that social interactions were of equal or greater importance than music performance. How, then, are musicians able to engage with each other in an effective manner and achieve rhythmic and behavioral entrainment when they cannot be physically present with each other? There have been reports of ensembles engaging in virtual rehearsals using software such as listed above; however, we know it is not possible to synchronize movement with others on virtual platforms given the laws of physics and limitations

of internet bandwidth. Does the audio-visual asynchrony experienced through glitches in a virtual digital platform disrupt feelings of social closeness in the same manner and magnitude seen in this study? Another approach to virtual group performance adopted by some music ensembles is for members to record their specific parts while listening to a click track, then submit these recordings for assembly into a single multi-track performance. In this case, synchronous performance can be achieved between the individual and the click track (presumably) but does this style of digital interaction promote feelings of social closeness and affiliation? I believe these are important and timely questions that require further investigation across multiple population demographics and will contribute to our understanding of interpersonal relationships in music ensemble contexts.

Limitations

This study focuses specifically on adult community instrumental musicians drawn from a single music organization in western Canada. As such, findings may not be generalizable to other populations such as school aged musicians, different community music groups, or even different genres of ensemble music. Groups sizes were not equal. The beginner group had 17 members, while the novice, intermediate, and advanced groups had an average of 50 people. This difference in group size can affect the results of the statistical analysis as the beginner group does not mathematically contribute as much to overall population measures compared to that of the other groups.

The group divisions within this study are also something to be approached with caution. Although these groups are generally divided by skill level, that does not necessarily reflect solid boundaries between groups. Age and experience on an instrument do not necessarily fully correlate to which ensemble the participants belonged and their musical cognition. For example,

some members of the beginner group are retirees who have the time and desire to learn a wind instrument. This does not mean they are not well versed in music. They may be highly sophisticated consumers of music, perhaps by attending live performances like the symphony, opera, or jazz, or through an expansive collection of recordings. Or, a member of a group may be a highly skilled singer or violinist but learning the flute for the first time. Similarly, a member in the intermediate group may have the technical ability to play in the advanced group but is not available on that rehearsal night. In these cases, music cognition could be more affected by motor pathways, which may have a different impact on feelings of social closeness than someone who is brand new to ensemble music or music performance and literacy. Equally, if a member has a hearing or vision impairment, or some sort of physical disability which prevents quick motor responses, the cognitive processes utilized for synchronous performance will likely be different than those of a regular hearing/seeing/moving musician. Although I did not specifically ask for this information as part of this study, there are participants who have hearing, vision, and physical impairments.

Implications and Directions for Future Research

The title of this study, "I play for togetherness," is taken from a comment made by a member of the novice band. It suggests ensemble musicians are motivated to perform not just for individual musical accuracy, but for collective musical alignment and social cohesion. Results of this study indicate disruption to the audio-visual sensory information experienced by adult community band members disrupts feelings of social closeness. These findings align with those of Keller, Novembre, and Hove (2014) who linked the cognitive-motor skills of mutual temporal adaptation, attention, and anticipation to the activation of structures in the brain associated

with socio-affective behavior and support the conclusion of a neurophysiological basis for how synchronous movement promotes social cohesion. Although this was a controlled experiment designed to imitate situations that occur in "real life" it is important to recognize that there are consequences beyond those of "the music just not sounding good." Given repeated instances of asynchrony, from which recovery proves particularly challenging if not impossible, such as what was experienced in this study, the cohesion of the group can erode.

This concept of group erosion is of vital importance when one considers the necessity for music ensembles to retain members from year to year, and indeed, week to week. Without consistent participation, music ensembles are not able to grow together as a team and develop a shared vision and understanding of each person's unique role within the ensemble. If a member does not feel that they are able to contribute positively or is resentful of poor contributions of other members, they may choose to leave the ensemble, which further disrupts the social interactions and closeness of the group. Although participants in this study recognized the somewhat artificial nature of the introduced asynchrony, they overwhelmingly said they would not continue to participate in the ensemble if this kind of unacknowledged asynchronous experience was the norm.

As long-term participation, positive perception of program value, and development of group skills are key goals of community organizations and educational institutions, dedicated participation and the collective expectation of high-level performance is essential. This is achieved through consistent, purposeful, and engaged rehearsals. It therefore behooves program administrators and conductors to actively develop interpersonal relationships and feelings of social closeness within its members through rhythmic and behavioral entrainment, and ensure attention to temporal precision and stylistic congruence on the part of the conductor.

The value of social closeness and group membership was noted by multiple participants. They indicated that band practice, even when things "went off the rails" was a vital part to their daily and weekly activities. These members indicated playing music with the group was a respite from the rigors of their daily routines, and any sacrifices endured to attend (travel, fatigue, workload) were worth the cost. They cared for each other and were supported by the other members of the band. Participation in the collective provided individual benefit, and instilled desire for continued regular participation. This finding aligns with the work of Dunbar and Schultz (2010) who determined members adjust their participation in response to perceived costs and benefits, Baumeister and Leary (1995) who articulated the desire for human beings to foster and maintain lasting interpersonal relationships, Durkheim (1912/1965) who described the positive results of group participation, and Higgins (2012) who determined hallmarks of community music include emphasizing equality of opportunity and fostering a diverse and welcoming environment for all.

Seemingly resilient to the negative effects of audio-visual asynchrony was the beginner ensemble. With less than two years of ensemble experience and still learning to navigate the multi-sensory environment of the wind band, their desire to continue to participate as a result of asynchronous conditions dropped slightly, but not significantly. This suggests that musicians who are early in the development of multi-sensory environmental management skills may be somewhat "buffered" to the effects of asynchrony perhaps as a result of an already full cognitive load. Awareness of asynchrony and the skills required to adjust one's performance to achieve synchronous performance then becomes a key learning objective to be addressed and reinforced by the conductor/music educator. An interesting question for further research is to compare the responses to asynchrony in groups of similar mean experience (less than 2 years) but are of

different ages. In this situation, as adults are more likely to have defined expectation of "what music should be" as a result of a lifetime of exposure to music, they may react differently to audio-visual asynchrony than elementary students who may not have developed rigid constructs around music. Adult beginners are also fundamentally different from elementary students in that they are experts in their "regular lives" and not necessarily comfortable with and resilient to managing the challenges of being a beginner (i.e., adults tend toward perfectionism and technical proficiency takes years to develop which results in highly critical attitudes and emotions). As such, does the disruption of sensory information such as what is experienced in times of audio-visual asynchrony, result in similar feelings of negativity toward self and others in adult beginners as in children/adolescent learners? On a similar vein, do children/adolescents have similar baseline SCI scores to that of adult beginners, especially given their stage in identity development? How does social closeness contribute to their desire to continue with band in school or in the community on an ongoing basis?

Given the findings of this study where the advanced band was not immune to the deleterious effects of asynchrony yet critically reacted to violations of ensemble performance expectations, further research may explore how different types of elite ensembles experience audio-visual asynchrony and manage the social consequences of asynchronous performance particularly given their leadership and membership paradigms. Do elite ensembles, who tend to be highly focused on product achieve the same levels of social closeness as community ensembles who may not be as focused on product, and can social closeness be disrupted through sensory asynchrony? How is the disruption to the goal of rhythmic joint action experienced by an elite high-school band with a festival performance on the line? As described by Boerner and Freiherr von Streit (2005), there is a possibility that the conductor's usage of directive leadership

endangers musician's motivation; well trained professionals do not require further leading. Would professional ensembles respond the same way as community ensembles to changes in visual information? Would their focus of blame be on the conductor, others, or themselves? Does the group tolerance to audio-visual asynchrony shift with different conductors?

This leads to the implication of the study on the importance of quality musical leadership. Quality musical leadership includes both pedagogical expertise which can support the learning of the group as individuals and as a collective across all levels of development, and expertise in the gestural language of conducting. This study demonstrates the importance of predictable, congruent gesture that has specific and musical meaning to the members of the ensemble. Many studies have examined the role and efficacy of conductor gesture (see Montemayor and Silvey, 2019; Meals, Morrison, & Confredo, 2018; Kumar and Morrison, 2016) but this study specifically underpins the vital role good conducting and musical leadership has on social cohesion. While formal control may undermine trust, because rules reduce players' autonomy to make decisions, social control, achieved through socialization into organizational culture, may encourage the development of trustworthy relationships (Khodyakov, 2007). This is not to say that bad conductors do not work with groups with strong social bonds, particularly if there is an established culture of collaboration and group input (see Biasutti, 2013), but good conducting does seem to support the social bonds between all members of the group, including the conductor.

Social cohesion and feelings of social closeness are hallmarks of a strong and effective ensemble. In these situations, group members who move in synchrony tend to experience physical and emotional entrainment. This entrainment leads to prosocial behaviors, increased solidarity and the desire to continue to participate. As positive emotions grow between the

members of the group in response to repeated synchronous joint action that is bolstered by group symbols, a sense of safety and belonging, and pursuit of collective goals, they experience *collective effervescence* (Durkheim 1912/1965) which results in a localized intensification of emotion with long term effects. These long-term effects result in continued participation in these groups with the goal of repeated experiences of emotional highs.

When groups are unable to synchronize, they may not reach a state of heightened positive emotion. In this study, I introduced audio-visual asynchrony into a regularly scheduled rehearsal of adult community band musicians in order to examine the effects of asynchrony on feelings of social closeness. The results were conclusive: audio-visual asynchrony does disrupt feelings of social closeness. It is important to note that this study was completed with a single population of adult community musicians and may not be generalizable to other populations of musicians such as school aged students or professionals. It does, however, demonstrate the importance of quality musical leadership and the necessity of large ensembles to promote positive social outcomes including belonging, interpersonal communication, and strong social bonds.

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Appendices

Appendix A: Participant Questionnaire

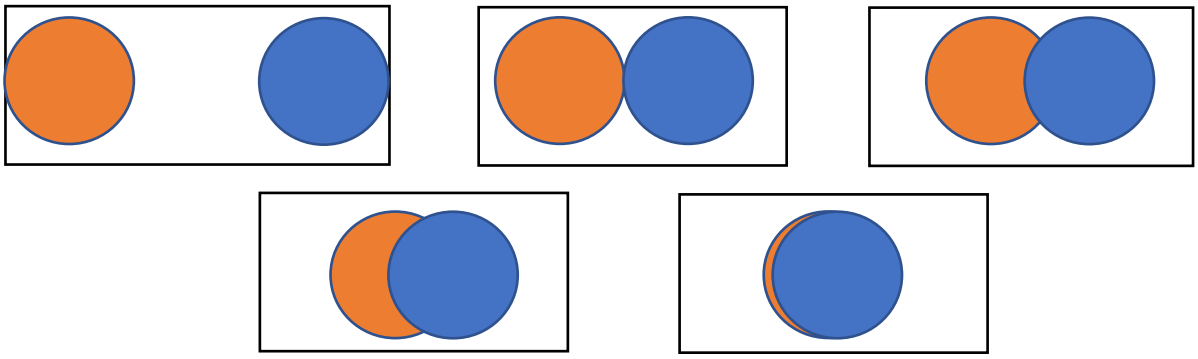
Part 1 – *Complete upon instruction after first rehearsal*

Instrument you are playing in this ensemble _____

Years of experience on the instrument you are playing in this ensemble _____

Gender _____ Age _____

9. Of the five pictures shown below, choose the one that best depicts your relationship to the other members of the ensemble **right now**.



10. How connected do you feel to the other participants?

1	2	3	4	5
Not at all				Very much

11. How likeable were the other participants in the ensemble?

1	2	3	4	5
Not at all				Very much

12. To what extent do you feel similar to the other members of the ensemble?

1	2	3	4	5
Not at all				Very much

13. In your opinion, how successful were you at synchronizing with the conductor?

1	2	3	4	5
Not at all				Very much

14. In your opinion, how successful were you with synchronizing your performance with others?

1	2	3	4	5
Not at all				Very much

15. How would you rate your <u>expectation</u> of playing in synchrony (together with the group) **before you began**?

1	2	3	4	5
Not at all				Very much

16. How well was your expectation of playing in synchrony (together with the group) met during this rehearsal?

1	2	3	4	5
Not at all				Very much

17. How difficult was it to perform with this group?

1	2	3	4	5
Not at all				Very much

18. How uncomfortable or embarrassed did you feel during the rehearsal?

1	2	3	4	5
Not at all				Very much

19. Who do you think is at fault for mistakes made during this rehearsal?

1	2	3	4	5
Me				Others

20. How enjoyable was this rehearsal?

1	2	3	4	5
Not at all				Very much

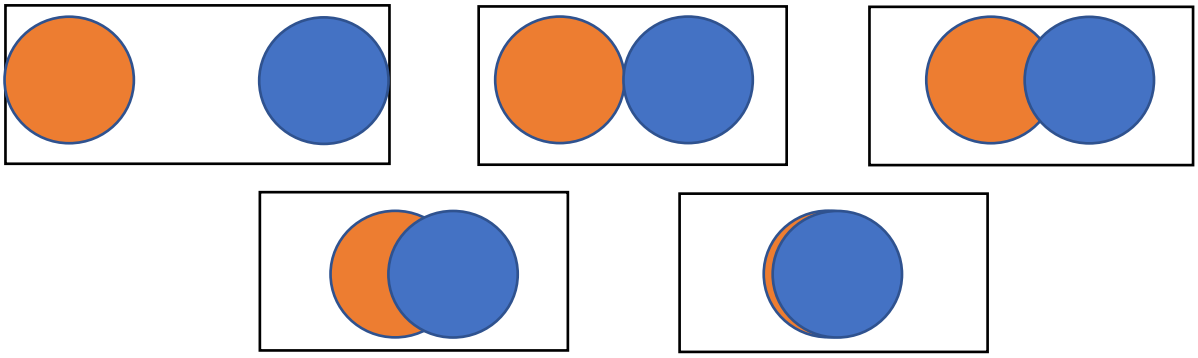
21. If this is generally how rehearsals go, would you want to rehearse or perform with this ensemble again?

1	2	3	4	5
Not at all				Very much

22. In a few words or short sentences, describe how you felt during this rehearsal.

Part 2 – *Complete upon instruction after second rehearsal*

1. Of the five pictures shown below, choose the one that best depicts your relationship to the other members of the ensemble **right now**.



2. How connected do you feel to the other participants?

1	2	3	4	5
Not at all				Very much

3. How likeable were the other participants in the ensemble?

1	2	3	4	5
Not at all				Very much

4. To what extent do you feel similar to the other members of the ensemble?

1	2	3	4	5
Not at all				Very much

5. In your opinion, how successful were you at synchronizing with the conductor?

1	2	3	4	5
Not at all				Very much

6. In your opinion, how successful were you with synchronizing your performance with others?

1	2	3	4	5
Not at all				Very much

7. How would you rate your expectation of playing in synchrony (together with the group) **before you began**?

1	2	3	4	5
Not at all				Very much

8. How well was your expectation of playing in synchrony (together with the group) met during this rehearsal?

1	2	3	4	5
Not at all				Very much

9. How difficult was it to perform with this group?

1	2	3	4	5
Not at all				Very much

10. How uncomfortable or embarrassed did you feel during the rehearsal?

1	2	3	4	5
Not at all				Very much

11. Who do you think is at fault for mistakes made during this rehearsal?

1	2	3	4	5
Me				Others

12. How enjoyable was this rehearsal?

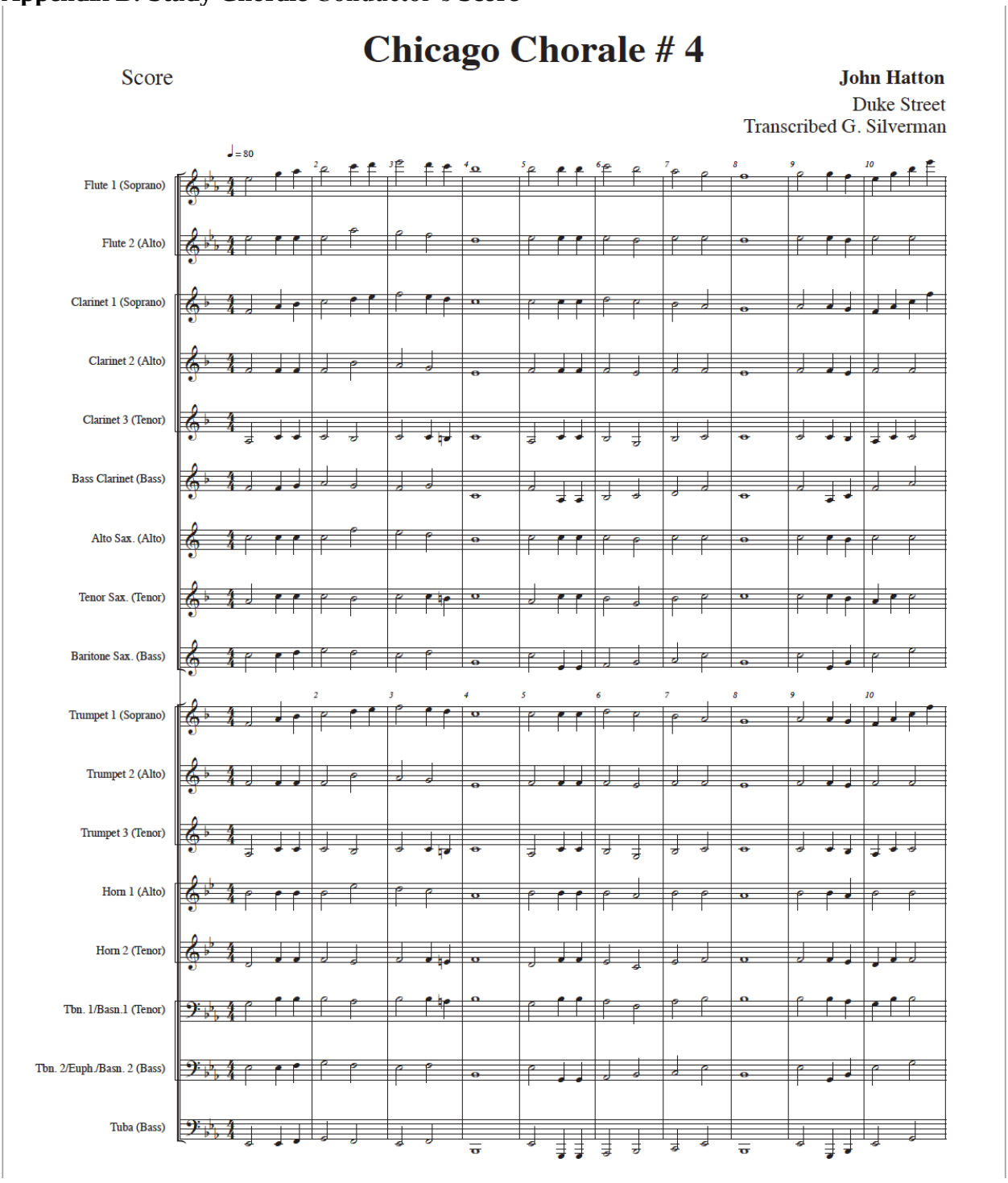
1	2	3	4	5
Not at all				Very much

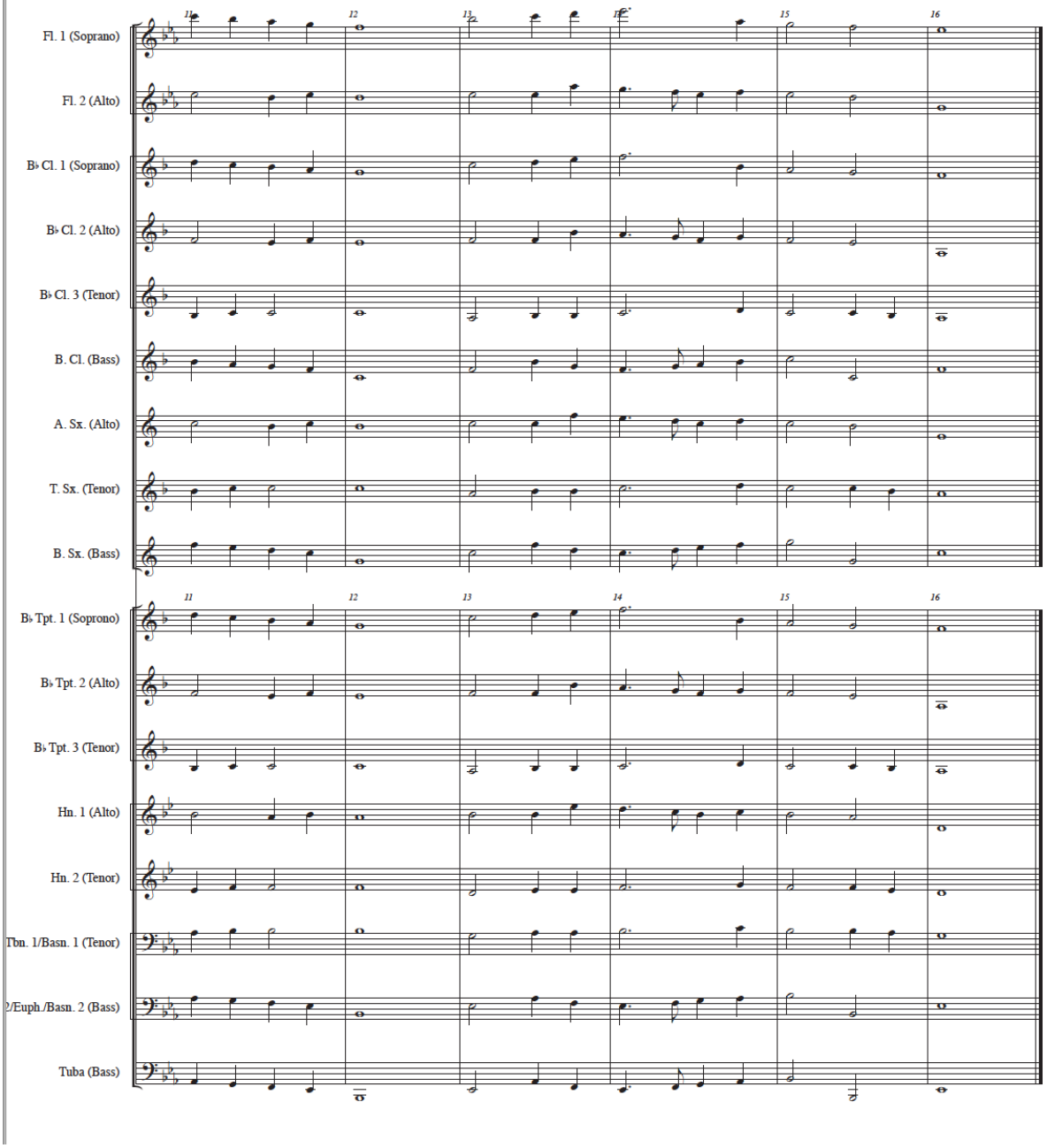
13. If this is generally how rehearsals go, would you want to rehearse or perform with this ensemble again?

1	2	3	4	5
Not at all				Very much

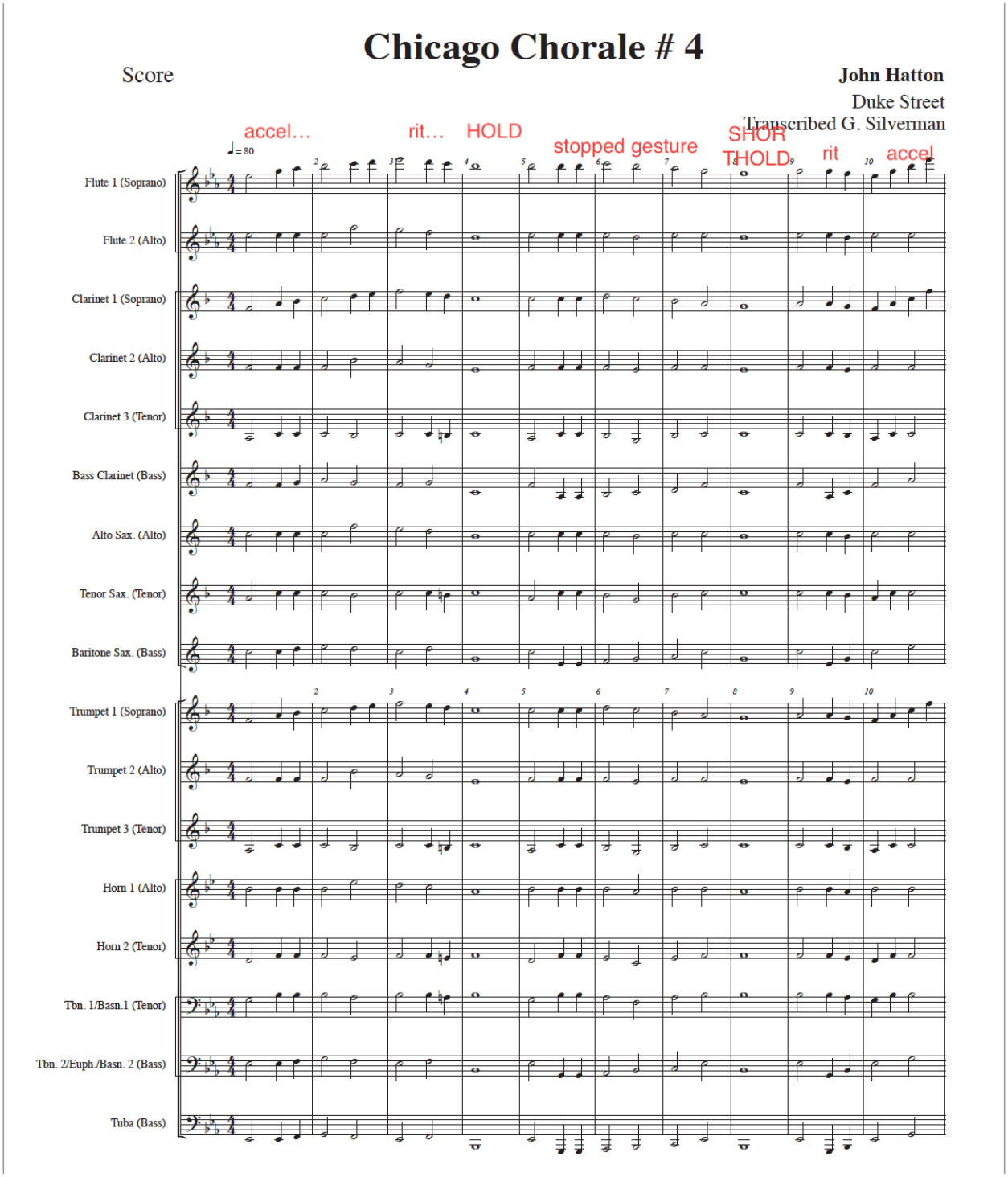
14. In a few words or short sentences, describe how you felt during this part of the rehearsal.

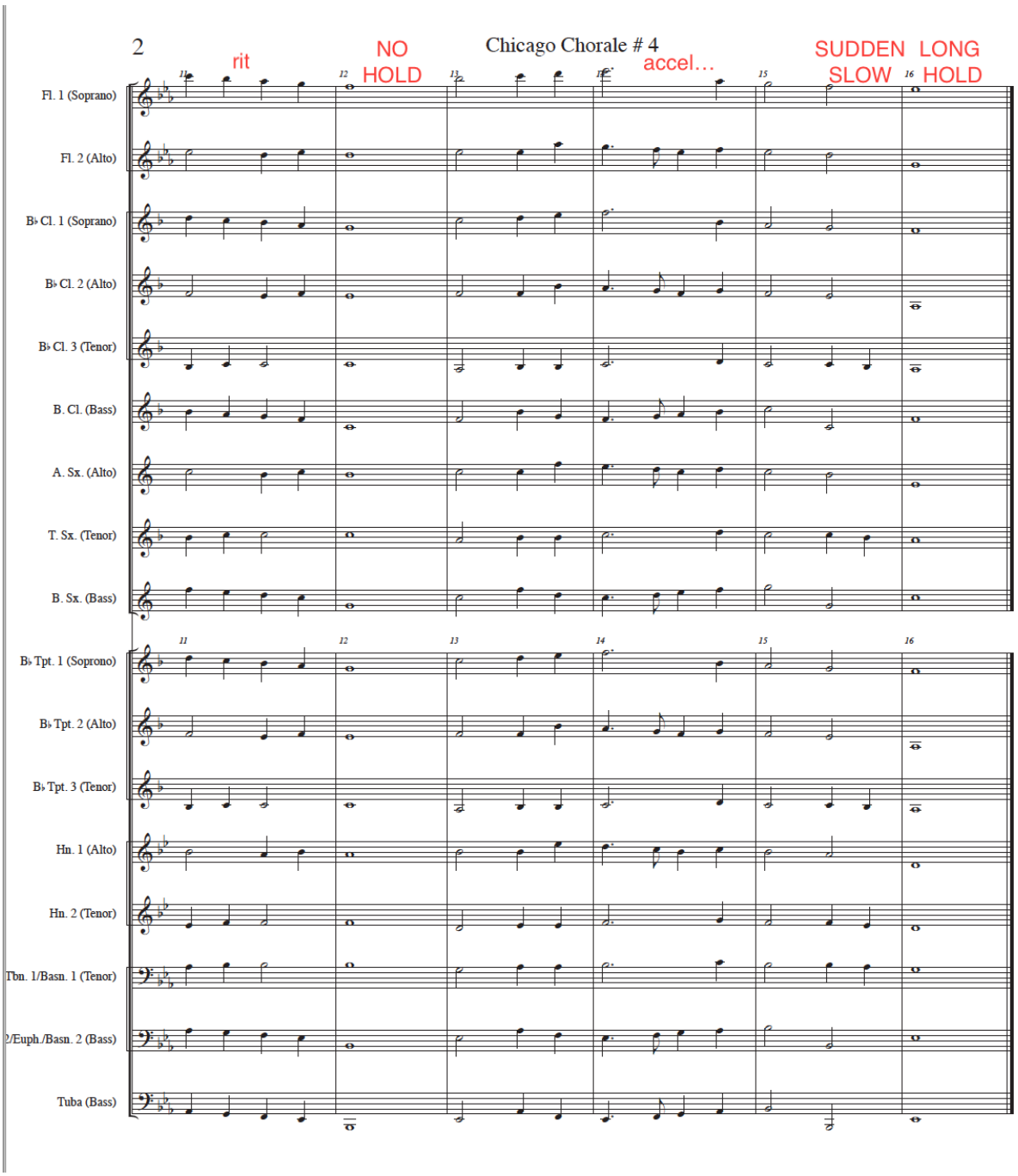
Appendix B: Study Chorale Conductor's Score




Chicago Chorale # 4
Fl. 1 (Soprano)
Fl. 2 (Alto)
B♭ Cl. 1 (Soprano)
B♭ Cl. 2 (Alto)
B♭ Cl. 3 (Tenor)
B. Cl. (Bass)
A. Sx. (Alto)
T. Sx. (Tenor)
B. Sx. (Bass)
B♭ Tpt. 1 (Soprono)
B♭ Tpt. 2 (Alto)
B♭ Tpt. 3 (Tenor)
Hn. 1 (Alto)
Hn. 2 (Tenor)
Tbn. 1/Basn. 1 (Tenor)
/Euph./Basn. 2 (Bass)
Tuba (Bass)

Appendix C: Experimental Condition Score




2
Chicago Chorale # 4
rit
NO HOLD
accel…
SUDDEN LONG SLOW HOLD
Fl. 1 (Soprano)
Fl. 2 (Alto)
B♭ Cl. 1 (Soprano)
B♭ Cl. 2 (Alto)
B♭ Cl. 3 (Tenor)
B. Cl. (Bass)
A. Sx. (Alto)
T. Sx. (Tenor)
B. Sx. (Bass)
B♭ Tpt. 1 (Soprono)
B♭ Tpt. 2 (Alto)
B♭ Tpt. 3 (Tenor)
Hn. 1 (Alto)
Hn. 2 (Tenor)
Tbn. 1/Basn. 1 (Tenor)
/Euph./Basn. 2 (Bass)
Tuba (Bass)

Appendix D: Participant Consent Form

UNIVERSITY OF WASHINGTON PARTICIPANT CONSENT FORM
Audio-Visual Asynchrony and Social Dynamics in a Wind Ensemble

Researchers	Position	Department
Taina Lorenz	Graduate Student	School of Music, University of Washington
Dr. Steven J. Morrison	Supervisor	School of Music, Northwestern University

Researchers' statement

I am asking you to be in a research study. The purpose of this consent form is to give you the information you will need to help you decide whether to be in the study or not. Please read the form carefully. You may ask questions about the purpose of the research, what I would ask you to do, the possible risks and benefits, your rights as a volunteer, and anything else about the research or this form that is not clear. When I have answered all your questions, you can decide if you want to be in the study or not. This process is called "informed consent."

PURPOSE

The purpose of this study is to explore the effects of audio-visual asynchrony on social dynamics within an ensemble. The study stimuli are designed to simulate "real-world" scenarios that occur in rehearsal and explore the responses of the performer to these situations.

STUDY PROCEDURES

If you agree to participate, you will play a simple chorale two times in a typical, conducted, ensemble setting. You will then be asked to answer questions about your experiences in this "rehearsal." You will then be asked to play the chorale two times more with altered sensory information and respond to the second part of the questionnaire. The entire session will take approximately thirty minutes to complete. This includes time for consent and questions.

RISKS, STRESS, OR DISCOMFORT

Since this task involves answering questions about your performances, as you perceive it, there are no incorrect responses. Your responses will not be shared with any participants or performers. Some people feel that taking part in research is an invasion of privacy. All performance data (questionnaire responses) will be completely anonymous. Demographic data, including instrument played, years of experience, gender and age will be collected for correlation analysis. All data collected will be kept secure and confidential.

BENEFITS OF THE STUDY

By analyzing responses to multi-sensory rehearsal conditions, I will better understand how performers navigate the dynamic environment of a large ensemble and help inform music educators on how they can support their players in these situations.

OTHER INFORMATION

Participation in this study is voluntary. You may refuse to participate, and you are free to withdraw from this study at any time without penalty or loss of benefits to which you are otherwise entitled. Information about you is anonymous. Identifying information will contain no links to your personal identity. If you have any questions about this study, you may ask me now or later. If you have any questions about my rights as a research subject, I can call the Human Subjects Division at (206) 543-0098 or call collect at (206) 221-5940.

Participant's statement

This study has been explained to me. I volunteer to take part in this research. I have had a chance to ask questions. If I have questions later about the research, or if I have been harmed by participating in this study, I can contact one of the researchers listed on the first page of this consent form. If I have questions about my rights as a research subject, I can call the Human Subjects Division at (206) 543-0098 or call collect at (206) 221-5940. I will receive a copy of this consent form if I desire.

Printed name of participant Participant signature Date

Copies to: Researcher
Participant (on demand)