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Exploring Focus of Attention in Music Learning

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Dedication

For my precious family, Brigette, Arch, and Joe –

Your patience, encouragement, and love keep me going.

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To all of my band director friends – I think of you often. Thank you for your inspiration over the years and the hard, hard work that you do.

Finally, to Mom, Dad, Emily and Susan – You taught me to be compassionate, smart, tough, and to work hard. I love you all!

Abstract

Exploring Focus of Attention in Music Learning

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The acquisition and refinement of complex motor skills requires that learners focus attention strategically in order to optimize performance outcomes. A considerable body of research across a variety of disciplines supports the idea that performers who focus their attention on the external effects of the body's movements experience enhanced performance outcomes, whereas those who attend more to the movements themselves are disadvantaged. The effects of attentional focus on motor performance are explained, at least in part, by the relationship between focus of attention (FOA) and automatic motor control processes that develop with practice; automaticity allows cognitive resources to be allocated toward the processing of information related to task goals rather than the physical movements associated with the task itself. We understand little about how this phenomenon may function in the initial stages of learning complex skills, such as playing a wind instrument, when learners must attend to the discrete physical components associated with tone production in order to generate more desirable outcomes and establish proper fundamentals.

In this dissertation, I report the findings of three studies designed to explore how FOA functions during ongoing instruction and self-directed practice. The first two investigations examined how experienced beginning band teachers instinctively direct students' attention to internal (e.g., embouchure) and external (e.g., tone) components of performance. In both studies, teachers focused student attention on predominantly internal performance components, but they differed idiosyncratically in how they directed learners' attention based on concurrent instructional goals and activities. Teachers frequently described relationships between internal and external components of performance (e.g., how embouchure manipulation affects tone), suggesting that they strategically paired physical behaviors with external effects in order to build students' knowledge of action-outcome relationships.

Finally, we examined how undergraduate music education majors enrolled in a brass methods course chose to focus their attention on internal and external elements of performance during self-directed practice on an unfamiliar brass instrument. Analysis of their practice verbalizations revealed that students with extensive training in brass performance reported focusing their attention on predominantly external elements, whereas the less experienced students described focusing on both internal and external elements relatively equally, often noting how their physical actions influenced external outcomes.

Taken together, these results suggest that learning and refinement of instrumental performance skills may be optimized when learners' attention is drawn to action-outcome relationships early in their training. Learners can recruit knowledge of these relationships when troubleshooting performance problems and think critically about how best to achieve musical goals. Classroom music teachers who explicitly verbalize the relationships between internal and external components of performance may therefore increase the efficiency with which students' skills and independence are cultivated over the long term.

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Chapter 1: Introduction and Review of Literature

INTRODUCTION

We spend the vast majority of our waking lives engaged in various forms of goal-directed behavior; we walk to the kitchen when we feel hungry, scan roadways to ensure that it is safe to cross, reach out to a crying child, and play instruments to make music. In each of these scenarios and in countless others we attempt to act on our environment in order to achieve our goals. Many of the environments in which we find ourselves are complex, dynamic and filled with information, some of which is relevant to our goals, some meaningless. And because our cognitive resources are limited, we require a mechanism that selectively collects the information we need—this is the role of our attention.

Having gathered relevant information, we engage our motor system as we move through and interact with the environment. Over the course of our lives, innumerable repetitions allow much of this motor control to be exerted automatically without conscious awareness or focused attention to the movements themselves (Schneider & Shiffrin, 1977; Shiffrin & Schneider, 1977). Once this automatic control, or automaticity, has been achieved, our attention is free to focus on relevant environmental stimuli and, more importantly, the goal itself (Logan, 1988, 1992).

In the case of music performance, the goal is to create beautiful, nuanced and sophisticated sounds that require physical movements of the body that are equally nuanced and sophisticated. Because we have some control over where our attention is focused, the question then becomes, “What should I attend to: the sounds I create or the physical movements that produce them?”

Extant research in motor learning and performance has repeatedly demonstrated that externally-focused attention on movement effects allows for the recruitment of automatic control processes in the motor system that run effectively and efficiently below our conscious awareness leading to optimal performance outcomes (Wulf, McNevin, & Shea, 2001). Conversely, internally-focused attention to the body’s movements interferes with automatic control processes in the motor system leading to decrements in performance. For well-learned, automatized skills, this dichotomy is almost certainly true. As anyone who has ever undertaken the often mystifying and frustrating work of learning a musical instrument can attest, however, attention to one’s first sounds provides little actionable information in the beginning—the sound is often unpleasant, and the learner may understand little, if anything, about how to change physical actions in order to create desirable outcomes. The most efficient solution is often to seek the guidance of a teacher.

Skilled teachers often focus their beginner students’ attention on the fundamental, physical components of performance, such as posture, hand position, and embouchure formation (Parsons & Simmons, under review; Worthy & Thompson, 2009). This effective and time-tested approach to improving overall tone quality soon allows the student to take on more mature and challenging repertoire that requires the acquisition of more advanced techniques, leading once more to a renewed focus on physical components of performance. As this process of skill acquisition and elaboration unfolds over time, control of physical skills will at some point be assumed by automatic processes in the motor system—that much is clear.

What remains unknown, though, is *how* and *when* automaticity develops for complex motor skills such as music performance. Beginning musicians grapple with executing multiple component skills that have to be coordinated and controlled simultaneously. If beginners focus attention primarily on the movements of their body, will that interfere with learning and performance as automaticity develops? Do effective teachers have an intuitive sense of how to focus student attention advantageously on internal and external elements of performance as skills develop over time? And, how do students focus their own attention when they practice alone and cannot rely on a teacher's guidance?

While most empirical findings in the context of music performance (Atkins, 2017, 2018; Atkins & Duke, 2013; Duke, Cash, & Allen, 2011; Mornell & Wulf, 2019; Stambaugh, 2017, 2019) lend support to those found in kinesiology and sports-psychology literature, the role of attentional focus in the context of music teaching and learning remains largely unexplored. In this dissertation, I explore the role of attentional focus in instrumental music learning, specifically in the contexts of group instruction and self-directed practice, incorporating contemporary models of motor learning (Wolpert, Gharamani, & Jordan, 1995; Wolpert, Miall, & Kawato, 1998) as well as motor control and automaticity (Logan, 2018; Logan & Crump, 2011; Ramnani, 2014) in an effort to contribute to our understanding of this complex interaction.

AUTOMATICITY AND HIERARCHICAL MOTOR CONTROL

Experts across many domains accomplish stunning demonstrations of skill while apparently paying little, if any, attention to their movements. A point guard can dribble swiftly past defenders while looking for an open teammate instead of the ball, or a pianist can improvise a solo that weaves elegantly in and out of chord changes with ease and expression while synchronizing his performance with the groove of the rhythm section. Such expert feats of goal-directed behavior are the result of years of skill refinement; at some point in their past, these performers executed the component skills associated with each task in an effortful manner that consumed the majority of their cognitive resources. After many hours of focused practice, control of the skills became automatic, allowing the basketball player and the pianist to shift their attention away from their movements toward task-related goals (Logan, 1988). But if the basketball player and the pianist are no longer thinking about their hands, what exactly is controlling those movements? And how are experts able to execute skills flexibly in a variety of contexts? Modern exploration of automaticity in skilled performance began in the middle of the 20th century; to this day, researchers continue to propose contemporary theories that explain the nature of automaticity and its role in human learning.

The Dual-Mode Model of Information Processing

In the 1950s, psychologists began to study the cognitive processes underlying complex human behavior. Schneider and Shiffrin were among the earliest prominent researchers in the field of cognitive psychology to study the way human beings grapple with incoming stimuli as they engage in goal-directed behavior. Their work described such cognitive processes in terms of two contrasting modes: automatic and controlled. According to Shiffrin and Schneider's (1977) dual-mode model of information processing, *automatic* processing occurs quickly and imposes low attentional demands that allow various operations to run simultaneously with little or no interference. Conversely, *controlled* processing occurs more slowly, is serial in nature (moving stepwise), intentional, and demands high levels of attention, which makes cognitive processing susceptible to interference from other concurrent tasks or distractions. Shiffrin and Schneider further explain that the two kinds of processing are distinct. After extensive task-specific practice, the execution of skills that formerly required high levels of attention when cognitive processing was controlled (e.g., a sequential order of movements) are governed by automatic processes—skills are more fluid and are executed below the level of conscious awareness. Furthermore, once skill components are executed using automatic processes, conscious attention to these components during task execution reinstates controlled processing that is slow and effortful, and performance suffers.

In a long series of experiments (e.g., Schneider & Shiffrin, 1977; Shiffrin & Schneider, 1977), Schneider and Shiffrin asked participants to perform a visual search task in which they identified the presence of target characters (e.g., numbers or letters) among non-target alternatives in two conditions. In the consistent-mapping (CM) condition, targets and non-targets were held constant; that is, targets in a given trial never became non-targets in another trial. In the varied-mapping (VM) condition, targets (e.g., letters) and non-targets (also letters) were randomly intermixed between trials so that a target on one trial became on non-target on another trial. Thus, over the course of several experimental sessions, CM target sets became well-learned (memorized) but VM sets did not. Participants could identify targets quickly (low response times, RTs) in CM conditions regardless of the number of items to be searched, whereas performance slowed (higher RTs) in the VM condition as the number of items to be searched increased (Schneider & Shiffrin, 1977; Experiment 2). These results suggested that RTs in the CM condition were faster because the cognitive processing required of participants had become automatic rather than controlled. To further explore the dual-mode model, Shiffrin and Schneider developed a variant of this search task to determine the extent to which well-learned automatic processes and effortful controlled processes might interfere with each other.

In one of their final experiments, Shiffrin and Schneider (1977, Experiment 4D) demonstrated that the search for CM targets became "automatic" over the course of participation and interfered with subsequent similar tasks. Participants who had previously become familiar with CM targets earlier in the experimental protocol were asked to search for VM targets appearing in specific visual locations while ignoring their appearance in other locations. On certain trials, a character from a previously-learned CM target set would appear in the locations that were to be ignored. Simultaneous presentation of previously-learned CM targets created significant delays (slower RTs) in VM target identification in this experiment, suggesting that search processes for VM targets were still highly controlled, and that previous and numerous repetitions of CM target searches had led to an automatic response associated with CM targets, which interfered with the simultaneous, primary search for VM targets. The slowing of RTs in this experiment was the result of inhibiting the automatic response to well-learned CM targets.

Though Shiffrin and Schneider initially characterized automatic and controlled processes as relative opposites, they did acknowledge that tasks governed by automatic processes may initially require controlled processing at the outset when contextually relevant information is assimilated, after which automatic processing takes over and the task is completed without conscious control (Shiffrin & Schneider, 1977). Despite this assertion, dichotomous, "all or none" views of controlled and automatic processing persisted until the latter half of the 1980s (for a review, see Moors & De Houwer, 2006).

One problem that emerged in the literature was the question of how to clearly define and characterize automatic processing. For example, Schneider and Shiffrin (1977) characterized automatic processing in terms of the *speed* and *efficiency* with which participants executed the search task in the CM condition. Posner, Snyder and Solso (1975) emphasized *intentionality*, defining automatic processing in terms of whether responses from a well-learned task, such as reading a word, would interfere with intended responses in another task, such as naming the color of ink the word is printed in (the Stroop paradigm; see Stroop, 1935). Some characterizations of automaticity have associated *processing* features (e.g., awareness, intention, efficiency, control; see Bargh, 1994) with *performance* features (e.g., speed, accuracy), but performance components often change at different rates over the course of ongoing practice (Logan, 1985) which adds another layer of complication. The variety of characterizations presented in the literature makes clear the difficulty of describing a covert cognitive process that underlies behaviors observed during task performance.

In part to solve the characterization problem, researchers and theorists placed a greater emphasis on attentional demand in investigations of automaticity because of its universality across tasks and domains. The term *automaticity* refers to the extent to which performance is controlled by automatic processes rather than controlled processes. Automaticity can thus be defined and measured by the degree to which simultaneous controlled or automatic processes interfere with a primary task; secondary (i.e., less relevant) stimuli are more likely to compete for a performer's attentional resources in a controlled process than in an automatic process. Sian Beilock's work with divided attention in dual-task paradigms provides some of the clearest examples of this phenomenon. Under dual-task conditions, performers are asked to do two things at once. For example, Beilock, Carr, MacMahon, & Starkes (2002) observed skilled soccer players completing a slalom-like dribbling course faster when their attention was focused on a skill-irrelevant distractor task (listening for a target word in a list of disparate words) rather than some aspect of the task itself (calling out which side of the foot just touched the ball). Novices performed faster when attention was focused on the skill at hand. These results suggest that, for experts, the dribbling task was processed automatically, allowing attention to be allocated to a task-irrelevant controlled process (identifying target words) during performance. The dribbling task still required undivided attention (controlled processing) for novices who could not allocate attention to the word task without suffering performance decrements. Findings from this study and others employing dual-task paradigms lend support to attention-based definitions of automaticity.

Automaticity as a Continuum of Memory Retrieval

Shiffrin and other scholars later adopted a less dichotomous view of cognitive processing as they began to present evidence for automaticity as a continuum (Moors & De Houwer, 2006). For example, interference with task performance commonly observed in a Stroop-type task can be significantly reduced with task-specific practice (MacLeod & Dunbar, 1988). Logan (1988) captured the importance of practice in the development of automaticity with his *instance theory of automatization* by redefining automatic processing in terms of memory retrieval, emphasizing when and to what attention is allocated during task performance rather than to whether processing occurs with or without attention. The instance theory proposes that during automatic processing, attention is allocated before task execution (pre-attention) which initiates the retrieval of past instances (memories) of a given set of stimulus-response relationships encountered during earlier practice. Practice not only increases the volume of instances in storage but the speed with which any one instance can be selected and retrieved, after which processing runs to completion with little or no conscious monitoring or control.

Logan (1992) later added that automaticity results in a shift in the performer's attention toward higher levels of processing and organization that optimize task execution, particularly those concerned with the integration of skill components (e.g., strategy in a game, sounds produced in music) rather than a reduction of attention levels during performance.

Developmental Concerns

Since the earliest work on automaticity, scholars have focused their research predominantly on the cognitive processes involved in declarative task performance in adult populations. Studying children is certainly more complicated as their rate of biological change remains high through early adulthood, making it difficult to attribute differences between groups or individuals to an experimental manipulation rather than to physiological differences related to age or maturation. Consequently, less is known about the acquisition and development of motor control in children than in adults. Evidence suggests, for example, that 6- and 8-year-old children learn motor sequences more slowly than adults do, but both groups improve with practice (Savion-Lemieux, Bailey, & Penhune, 2009). Do children, using the same controlled and automatic processing mechanisms, simply require more practice than do adults in order to develop automaticity? Or are there fundamental differences in cognitive processing between the two groups that govern sequence learning and performance?

Ruitenberg, Abrahamse, and Verwey (2013) set out to answer this question, focusing on the processing theory of *motor chunking*, in which motor sequences are learned and performed in a hierarchical fashion. Individual sequence elements (e.g., keystrokes) are held as a group in a single memory representation (chunk), then chunks themselves can be ordered and executed sequentially until the task is complete (Verwey, 1996). Note that in this case the authors defined automaticity as "performance that is largely on motor chunk use [*sic*] controlled by an autonomous motor processor" (Ruitenberg et al., 2013; p. 608). Ruitenberg and her colleagues employed a set of 3- and 6-keypress tasks with two different age groups, preadolescents (mean age=11.3 years) and young adults (mean age=22.0 years). For half of the participants in both age groups, 6-key sequences were structured (divided into two chunks of 3 keypresses) via a brief pause in stimulus presentation during training to determine the extent to which each age group relied on chunking to learn and automatize the task. Upon completion of training, all participants completed a questionnaire to assess their explicit knowledge of their assigned sequences. They were asked to write the correct keystrokes in order and to identify their sequence among alternatives.

The test phase involved three counterbalanced conditions designed to reveal differences in automaticity gains, both between age groups and structured/unstructured groups: a familiar condition in which trained stimuli were presented with imposed segmentation removed, a single-stimulus condition in which only the first character of a sequence was presented (participants then completed the rest of the sequence), and an unfamiliar condition in which novel 3- and 6-keypress sequences were presented. The investigators' prediction was that if children benefit from chunking mechanisms during training, response times (RTs) for the structured group should be faster than for the unstructured group for both 3- and 6-keypress sequences in the familiar and single-stimulus conditions but not for untrained sequences (the unfamiliar condition).

Mean reaction times (RTs) improved with practice for both age groups, though preadolescents were generally slower, and familiar sequences were faster than unfamiliar sequences for both groups at test. Test performance in both age groups benefited from the structured training condition but this effect was less pronounced in preadolescents, who also completed fewer correct 6-keypress sequences in the single-stimulus condition than young adults. Post-training questionnaire responses indicated that preadolescents had acquired less explicit knowledge of their assigned sequences than did the young adults. Interestingly, preadolescent performance in the single-stimulus condition at test was positively correlated with their responses on the explicit knowledge questionnaire, suggesting that preadolescents relied more than did young adults on some combination of explicit sequence knowledge and visual stimuli when executing the movements associated with familiar sequences.

These results suggest that children are more limited in their capacity to automatize sequential motor skills and rely more heavily on top-down cognitive processing (i.e., working memory) than are young adults, who seem to transition more readily to motor processing (i.e., chunking). These age-related differences may stem from immature brain anatomy present during childhood and adolescence. Ruitenberg and her colleagues point out that between the ages of 8 and 30, the basal ganglia change very little, but many areas of prefrontal cortex and the cerebellum are still developing during adolescence. These three brain areas are strongly associated with automaticity in adult populations and will be discussed further in the next section.

Neural Correlates of Automaticity and Hierarchical Control

A search for the neural structures and circuitry that underlie automaticity has gained momentum in recent years. If controlled processing is both conscious and effortful, then areas of the brain associated with decision-making and executive function such as prefrontal cortex (PFC) should become comparatively less active during the performance of well-learned tasks.

Using a variant of the dual-task paradigm (see above, Beilock et al., 2002), Poldrack and his colleagues (2005) asked young adults to learn a serial reaction time (SRT) task in which a visual target appeared in one quadrant of a screen in both sequenced and pseudo-random orders. Participants then pressed one of four keys corresponding to the target's location on the screen. In order to measure gains in automaticity, the same SRT task was periodically accompanied by a simultaneous tone-counting task. Functional magnetic resonance imaging (fMRI) scans were conducted before (i.e., during initial training) and after an intervening training session during which participants performed the SRT task in both single- and dual-task conditions. As expected, participants' response times were fastest in the single-task condition and improved throughout training, but slowed significantly during the dual-task condition. Post-training dual-task fMRI data revealed decreased activation in PFC as well as in its subcortical targets in the basal ganglia, which serve as a major hub for the transmission of motor signals. Activation of supplementary motor cortex and the basal ganglia, specifically in the putamen (receives inputs from cortex) and globus pallidus (projects onto the thalamus), decreased with training in sequenced stimulus patterns but not in pseudo-random patterns, confirming their role in sequence learning. Together, these trends in brain activation demonstrate a need for top-down, executive control during training that is reduced with practice.

Based on a wide array of similar experimental findings, Ramnani (2014) proposed a hierarchically organized corticocerebellar system of motor control that governs the learning and execution of motor movements with an emphasis on the role of cerebellar circuitry and the processing of internal models (Wolpert, Gharamani, & Jordan, 1995; Wolpert, Miall, & Kawato, 1998). In this proposed system (see Figure 1.1), a controller (PFC) sends representations of intended actions to motor cortex where a motor command is generated. When the command is sent to the motor system for execution, a copy of the command (known as an efference copy) is sent simultaneously to discrete areas of cerebellar cortex, where it is held for later processing and comparison in an internal forward model, which computes predictions about the expected consequences of the command. After the command is executed, sensorimotor signals arrive in the cerebellum via the inferior olive, a substructure of the brain stem. Here, the forward model compares the expected outcomes of the original command with the sensorimotor feedback that follows execution of the command. Discrepancies between the expected and actual outcomes trigger the transmission of error signals from the cerebellum through the thalamus to prefrontal and motor cortices where motor programs are updated for future recall. Errors are gradually minimized with practice as the accuracy of both commands and model predictions improve.

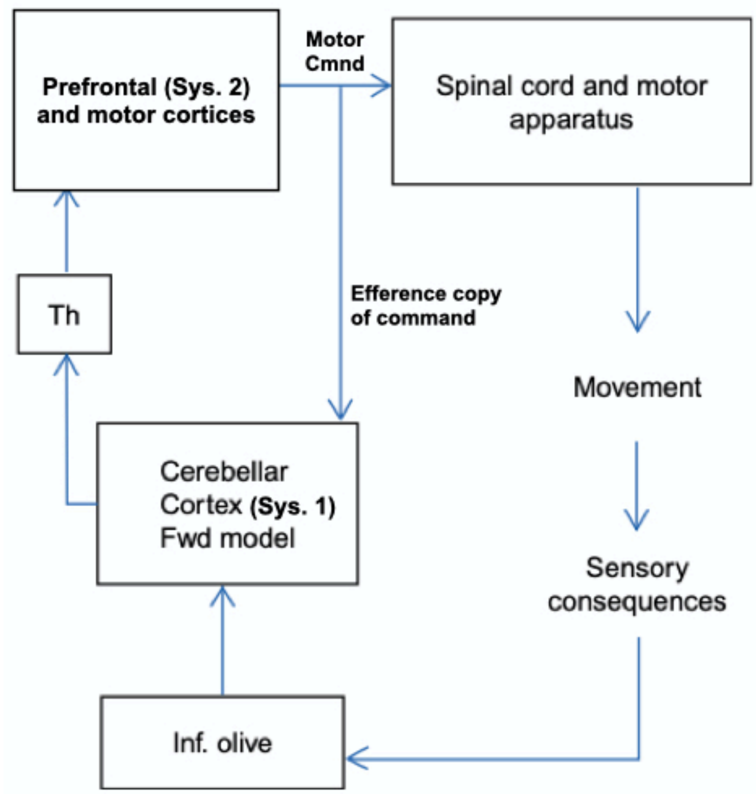


Figure 1.1. A simplified schematic diagram of a proposed corticocerebellar system. Adapted from Ramnani, N. (2014). Automatic and controlled processing in the corticocerebellar system. In *Progress in Brain Research* (Vol. 210, pp. 255-285). Elsevier. Note: System 1=automatic control; System 2=conscious control; Th=Thalamus.

This process unfolds largely without top-down intervention. That is, processing in PFC (referred to by Ramnani as System 2, see Kahneman, 2011) is responsible for selecting and generating movement representations whereas cerebellar (System 1) and motor system processing interact to control movements automatically below conscious awareness. Thus, under Ramnani's proposed model, automaticity emerges from the passage of increasing amounts of cognitive control of movement from System 2 to System 1 over repeated trials, freeing PFC of top-down control of motor execution and reducing its role to simply selecting movements and passing their representations on to the motor system and cerebellar circuitry. This is the same advantage proposed by cognitive theories of automaticity; without top-down processing, cognitive resources (e.g., working memory) can be reallocated for other purposes. Gordon Logan (2018) has proposed a similar, behaviorally testable model of two hierarchically nested control systems that will be discussed at length in the next section.

Hierarchical Control and Logan's Two-Loop Theory of Typing

As discussed above, Logan (1992) pointed out that automaticity is defined in part by a *shift* in the way an individual directs their attention during performance, rather than a *reduction* in attentional resource demands. If, for example, over the course of practice a pianist's attention shifts away from the control of the fingers that correspond to a given passage and toward higher order goals (e.g., playing the passage with a subtle crescendo), then what process has assumed control of her hands and fingers? And how is this control influenced by her intentions?

Logan and Crump (2011) proposed a hierarchical *two-loop theory of typing* in which an outer processing loop (working memory) identifies words to be typed (i.e., desired effects of physical movement) and sends the information one word at a time to an inner processing loop (motor system) where the movements associated with the word's constituent letters are sequenced and executed automatically (see Figure 1.2). Note that this theory is only intended to describe the organization of cognitive processing and the performance of *skilled* typists. The inner loop is encapsulated within the outer loop

(Logan & Crump, 2010); that is, the outer loop is only aware of the inner loop's function to the extent that it can monitor and respond to the inner loop's output (i.e., a word appears on the computer screen). Thus, the outer loop of a skilled typist has little direct or explicit knowledge of which letters are assigned to the keys on the keyboard, which fingers are assigned to those keys, and how to plan and execute finger movements during performance (Snyder, Ashitaka, Shimada, Ulrich, & Logan, 2014). The role of the outer loop is simply to control performance by selecting words to be typed (Crump & Logan, 2010), monitoring the inner loop's output at the word level via visual feedback (Snyder, Logan, & Yamaguchi, 2015), and adjusting performance parameters such as overall typing rate (Yamaguchi, Crump & Logan, 2013). It is important to note that although Logan and his colleagues have studied skilled performance in the domain of typing largely because of its ubiquity, it is their assertion that the two-loop theory (or one with a similar hierarchical structure) should generalize to many other domains including music (Logan & Crump, 2011; Logan, 2018).

The two-loop theory stands in sharp contrast to earlier "all or none" theories of automatized motor control that fail to explain *how* movements are controlled once top-down processes are no longer required; specifically, it describes how both controlled and automatic processing play an important role in skilled behavior, rather than *whether* processes are controlled or automatic. The two-loop theory proposes that working memory controls performance in a top-down manner by selecting desired movement effects, while the motor system controls and executes the required movements automatically. In 2018, Logan proposed a computational model describing the organization, processing and control of motor movements within the inner loop (see Logan, 2018).

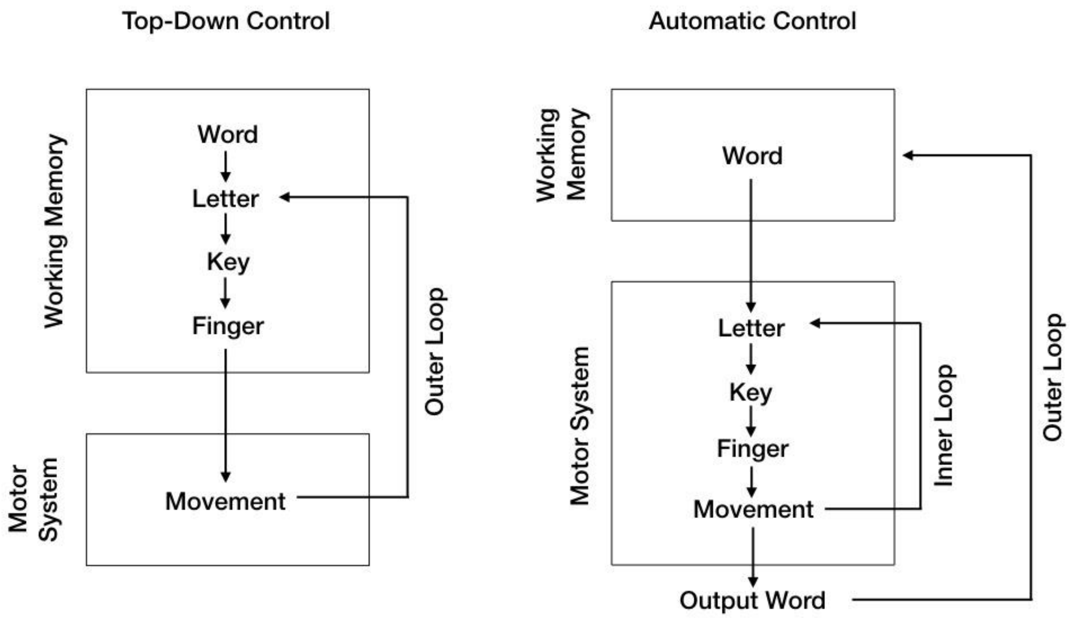


Figure 1.2. Typing under top-down control (left) and automatic control (right). Note the increased delegation of control to the motor system under automatic control. Adapted from Logan, G. D. (2018). Automatic control: How experts act without thinking. *Psychological Review*, 125(4), 453–485.

Logan and Crump's (2010) investigation of error detection in skilled typists serves as a robust demonstration of the hierarchical nature of automatized motor control. In a series of three experiments, skilled typists (university undergraduates) were presented with 5-letter words on a computer monitor and asked to type the word as quickly and accurately as possible. Participants' responses appeared on the monitor either as entered by the participant (whether correct or incorrect) or with errors covertly inserted by the computer (approximately 6% of total trials). On the remaining 94% of trials, 45% of participants' errors were corrected by the computer (i.e., the response on the monitor appeared to be correct despite the typist having committed an error). Although overall error rates were low (approximately 10% of total trials across the three experiments conducted in the study), participants consistently took credit for both corrected and inserted errors in both post-experiment and post-trial reports, though the proportion of participants showing such "illusions of authorship" decreased as the number of trials they performed increased. Interestingly, inter-keystroke interval (IKSI) data revealed post-error slowing after both actual and corrected errors but not after inserted errors (see Figure 1.3). This dissociation between participants' declarative knowledge of their own performance and patterns found in their motor performance suggests that the inner loop (motor system) utilizes haptic (the feel of the keyboard) and sensorimotor feedback while the outer loop (working memory) relies on visual feedback.

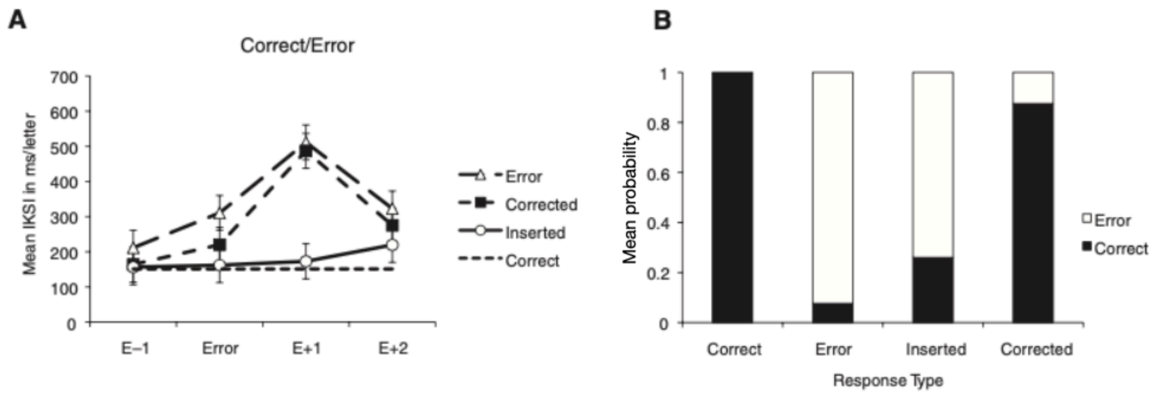


Figure 1.3. Performance and questionnaire response data from Logan and Crump (2010), Experiment 2. (A) Mean inter-keystroke intervals in milliseconds for individual letters preceding an error (E-1), an error and the two letters following an error (E+1, E+2). Symbols indicate whether an error was committed by the typist (error), or corrected/inserted by the experimenters. (B) Mean probabilities of participants reporting correct or error in trials containing correct keystrokes, incorrect keystrokes (error), inserted errors and corrected errors. From Logan, G. D., & Crump, M. J. C. (2010). Cognitive illusions of authorship reveal hierarchical error detection in skilled typists. *Science*, 330(6004), 683–686.

Logan and Crump (2009) were interested in exploring the notion that focusing attention toward physical movements and away from performance goals disrupts skilled performance. Specifically, why would attending to the physical aspects of a task disrupt a skilled performer? Though well-known, there was little empirical evidence documenting and explaining this phenomenon (see Beilock et al., 2002).

First, participants were instructed to type both unimanual (e.g., “read” or “jump”) and bimanual (e.g., “leap”) words that appeared on a computer monitor. In order to focus attention on the hands, a cue appeared prior to the presentation of a given word instructing participants to type either the whole word or only the letters of the word assigned to the left or right hand (in the case of bimanual words). These left- and right-hand cues led to huge performance disruptions. For example, in the case of the unimanual word “dart,” both left- and whole-word cues required identical responses, but response times (RTs) and inter-keystroke intervals (IKSI) were much longer (roughly 20%) for left-hand cues than whole-word cues, suggesting that forced attention to the hands required the typist to exert top-down monitoring of performance to ensure success.

Next, participants (who had not participated in Experiment 1) completed the same procedure, but the instructions to type with left, right or both hands were replaced by color-coded letters in the stimulus word. Participants were instructed to type either the green letters (letters assigned to the left hand) or the red letters (letters assigned to the right hand). Color-letter relationships were counterbalanced among participants. Thus, participant attention was focused on the visual properties of the stimulus, not the hands. Very little disruption in typing performance was observed. Because instructions for the desired hand were visually embedded in the stimulus directing attention away from the hands, working memory sent only the representations for the intended letters to the motor system, which then had little trouble executing the corresponding motor commands.

In Experiment 3, participants who had not served in the previous experiments completed the same procedure as Experiment 1 with the instructions again focused on the hand (the cues were “LEFT”, “RIGHT” and “WHOLE”), but all stimuli required only one hand. Thus, all words and letters to be typed were unimanual and, unlike in the first two experiments, inhibiting a familiar response (either the first letter of a word, or a word in its entirety) was never required. The experimenters included two bimanual “catch trials” (i.e., the same stimuli and cues used in Experiment 1) after participants had completed the unimanual trials. Following the procedure, participants completed a questionnaire which assessed what they had learned about the words. Attention to the hands again caused disruption in typing performance despite the fact that hand cues never required the typist to identify certain desired letters amongst undesired letters, and only 3 of the 16 participants reported learning that all the words were unimanual. Combined, these data suggest that participants were slowing their typing rate in an effort to visually scan the word to be typed for unwanted letters though, with the exception of the bimanual catch trials, none were ever presented.

In the fourth and final experiment, designed to generalize the single-word findings observed in Experiments 1-3 to continuous typing, participants were asked to type four paragraphs from Logan and Zbrodoff's (1998) typing test under four counterbalanced conditions: typing all letters, left-hand letters only, right-hand letters only, and every other word. Participants' performance when typing all letters was fast and accurate. Focused attention to the hands following left- and right-hand cues again created large disruptions in both speed and accuracy, whereas typing was slow but accurate when attention was focused on the visual stimulus by cueing participants to type every other word.

Taken together, the results of these experiments demonstrate that in skilled typists, working memory has been freed of the burden of controlling the movements of the fingers and instead sends word representations to the motor system and monitors motor system output (the appearance of the screen). Under normal typing conditions, the motor system of a skilled typist processes each word representation, converting the information into motor commands. Furthermore, when attention is focused on the hands, conscious control processes constrain the motor system's performance in an effort to assume control of motor execution, a task that is normally performed quickly and accurately by the motor system when left alone. As Logan and Crump put it, "In typing, the outer loop monitors the keystrokes on the screen and asks the inner loop to make the screen look right. The hands are out of the picture" (Logan & Crump, 2009; p. 5). Thus, during optimal (automatized) performance under normal conditions, the outer loop only attends to movement effects. The performance benefits of allocating attentional resources to the effects of the body's movements across a variety of skill domains, including music, will be discussed in the next section.

FOCUS OF ATTENTION

The learning and performance of complex procedural skills in music engage cognitive processes that underlie both decision making and the sophisticated coordination of perceptual and motor systems. Dedicated performers practice countless hours to master skills, both in the short- and long-term, utilizing feedback from observers and their own sensorimotor perceptions to make discriminations between intentions and outcomes that gradually refine perceptual skills and inform action planning (Chaffin & Imreh, 2002; Wulf, Shea & Lewthwaite, 2010). As expert performers in many fields can attest, the primary goal of this deliberate practice (Ericsson, Krampe, & Tesch-Römer, 1993) is not only to reliably produce desired performance outcomes, but to do so with automaticity (i.e., minimal conscious control). The advantage of this kind of procedural motor memory recall is clear—the performer is free to allocate cognitive resources to the processing of other relevant stimuli, such as synchronizing her performance with other musicians (Brown, Zatorre, & Penhune, 2015; Chaffin & Logan, 2006; Ramnani, 2014).

Once developed, however, automatized skills are not impervious to interference from cognitive (e.g., attentional focus) and environmental (e.g., external noises) distractions that occur during the performance of a well-learned skill. Over the last two decades, investigators who study motor learning and performance in many contexts (e.g., sports skills) have observed improved performance outcomes when participants are directed to focus their attention on some effect of their actions (external focus, EF) rather than the physical actions themselves (internal focus, IF) (Shea & Wulf, 1999; Vance, Wulf, Töllner, McNevin, & Mercer, 2004; Wulf, Höß, & Prinz, 1998; Wulf, Lauterbach, & Toole, 1999; Wulf, McNevin, & Shea, 2001; Wulf & Prinz, 2001; Wulf, Shea, & Park, 2001; Wulf, Weigelt, Poulter, & McNevin, 2003). Here, the term *focus* could refer to a part of the performer's body (e.g., fingers) or any environmental stimulus that is relevant to the performance of the skill at hand (e.g., basketball hoop). The benefits of an external focus in motor skill performance have also been observed when the distance between the performer and the EF increases (Maddox, Wulf, & Wright, 1999; McNevin, Shea, & Wulf, 2003; Totsika & Wulf, 2003; Wulf, McNevin, Shea, & Wright, 1999) and when the level of participants' task-related expertise differs (Wulf, Lauterbach, & Toole, 1999; Wulf, McConnel, Gärtner, & Schwarz, 2002; Wulf, McNevin, Fuchs, Ritter, & Toole, 2000).

To synthesize the overwhelming evidence for the benefits of an external FOA in motor learning and performance, Wulf and colleagues developed the constrained action hypothesis (Wulf, McNevin, & Shea, 2001), which proposes that an internal FOA brings motor movements under conscious control, resulting in interference with automaticity and performance decrements. In contrast, an external FOA allows for the recruitment of automatic control processes that operate below conscious awareness, resulting in performance enhancements. Wulf and Lewthwaite (2016) have subsequently incorporated this hypothesis in their OPTIMAL (Optimizing Performance Through Intrinsic Motivation and Attention for Learning) theory for motor learning, which proposes that learner autonomy generates enhanced learning expectancies that, when combined with externally focused instruction, directs attention toward task goals and enhances both motor learning and performance.

More recently, researchers have studied the effects of attentional focus in music tasks using both novice and expert performers; generally, the results from these investigations have lent support to the constrained action hypothesis. For example, novice pianists (collegiate music majors specializing in instruments other than piano) and expert pianists performed a simple, alternating finger pattern under different FOA conditions (Duke, Cash, & Allen, 2011). The experts were unaffected by FOA condition (performing equally well under IF and EF conditions), whereas the novice performers' movements were more even when focus conditions shifted from internal (e.g., "think about the fingers") to any of the three external elements of performance (e.g., "think about the keys/hammers/sound").

Duke and colleagues' (2011) demonstration of the benefits of an external FOA in piano performance inspired further investigations in a variety of music contexts, yielding results that are somewhat mixed. Trained and untrained vocalists' tone quality generally improved as their attentional focus became more external (e.g., feeling the vibrations in the throat with two fingers in an IF condition, or filling the room with sound in an EF condition) (Atkins, 2018; Atkins, 2017; Atkins & Duke, 2013). Using a protocol similar to that of Duke et al. (2011), Stambaugh (2017) asked music majors with either secondary-level (i.e., novice) or high-level (i.e., experienced) woodwind skills to perform an alternating-finger pattern on a MIDI wind controller. Though participants generally performed less evenly and accurately in a control condition compared to FOA conditions at the outset (Day 1), no significant FOA effects were found overall (Day 2). Stambaugh acknowledges numerous reasons why these results appear to contradict the findings of previous research, including the participants' prior music experiences, practice habits, preferences for internal or external foci in routine practice behavior, and the novelty of performing on the MIDI wind controller. In her most recent study, Stambaugh (2019) measured the effects of FOA conditions on second-year wind players while performing isochronous interval patterns on their instrument, and reported no significant differences in participants' performance between IF and EF conditions.

While the aforementioned studies employed predominantly discrete music tasks and measured performance in relatively objective terms, Mornell and Wulf (2019) chose a more ecologically valid approach, conducting two experiments with highly-trained musicians performing self-selected repertoire on their principal instrument in a repeated-measures design (i.e., all musicians performed control, IF, and EF conditions in counterbalanced order). Expert raters evaluated performances using subjective rating scale criteria; in both experiments, participants received higher musical expression ratings in the EF condition (e.g., "focus on playing for the audience and the expressive sound of the music") than in the IF condition (e.g., "focus on the precision of [your] finger movements and correct notes"), and in Experiment 2, participants were rated higher on technical precision in the EF condition than in the IF condition.

No studies to date, both in and outside of music, have attempted to characterize the role of attention in the process of motor skill development across extended periods of time and in group contexts, where teachers aim to focus their students' attention advantageously through the directives and feedback they provide. Although research questions and operational definitions that are common in FOA literature have not been included directly in music education studies beyond those described above, many scholars have characterized the verbalizations of successful teachers that were clearly meant to draw their students' attention to aspects of performance that required modification (Cavitt, 2003; Colprit, 2000, 2003; Derby, 2001; Worthy & Thompson, 2009). While these authors focused on more broad instructional goals that comprise several minutes of instruction, they provide a sense of how teachers are directing their own attention, and subsequently that of their students, to both internal (e.g., embouchure) and external (e.g., tone quality) elements of performance. Although motor learning terminology was not originally applied in these studies, we have retrospectively woven internal and external FOA designations (appearing in parentheses throughout the next paragraph) into the discussion of these results.

What these descriptions of music teaching suggest is that both internal and external aspects of music performance are targeted regularly by teachers, although the proportion of IF to EF targets tends to shift in the direction of external focus relative to students' experience. For example, Worthy and Thompson (2009) identify pitch accuracy (EF) as well as posture and instrument carriage (IF) as the most frequently expressed instructional goals in their observations of beginning band instruction, whereas middle school band directors rehearsing more experienced instrumentalists targeted pitch accuracy, tone and intonation (EF) most often (Cavitt, 2003). In her observations of string teachers, Colprit (2003) noted that although they targeted intonation, note accuracy, and bow distribution (EF) more frequently than the body, student performance was most successful following instances when teachers had identified physical components of performance (IF). She also noted that teachers expressed external targets more frequently as learners' age and skill increased and repertoire became more sophisticated, an idea that is consistent with the teaching of artist-level university applied instructors described by Duke and Simmons (2006). In their observations, external elements of performance were the principal means by which teachers conveyed goals to students, and even when internal targets were identified (e.g., motion of the hands in the performance of piano chords), teachers described the aural effect created by the body's movement.

Despite the contributions of this research, we know little about the manner in which teachers direct their students' attention to discrete internal or external components of performance in the context of naturalistic group instruction. It is also unclear whether teachers make strategic, albeit intuitive, choices in this regard, shifting their students' focus between specific internal and external components dependent on either the performance goal at hand or students' level of skill and automaticity.

SELF-DIRECTED PRACTICE

Certainly, one of the most important roles of a music teacher is to be a guide, focusing a student's attention on relevant aspects of performance in an effort to optimize both the learning process itself and musical outcomes for students. But how do learners navigate this process in the absence of a teacher's guidance? To answer this question, research examining the behavior and cognition of independent musicians, especially in the context of self-directed practice, has gained momentum in recent years. Much of this work began in the wake of Ericsson and his colleagues' seminal paper on deliberate practice (1993), which examines how learners' behavior, cognition, and performance in the context of self-directed practice differs relative to performers' expertise and experience. Though the studies described below did not seek to investigate specifically the role of attentional focus in music learning and performance, they do provide valuable insights into how learners apply cognitive processes and resources during the act of music making.

Ericsson and his colleagues (1993) described deliberate practice, first and foremost, as a highly structured activity for which the attainment and improvement of skill is the primary goal, in contrast to everyday activities where learning occurs passively or indirectly. Deliberate practice can also be defined in part by, “the subjects' motivation to attend to the task and exert effort to improve their performance” (Ericsson et al., 1993; p. 367). Thus, focused attention during performance is a requisite for deliberate practice in order to maximize perceived feedback which, in turn, informs future action. Practice without focused attention to performance may even be detrimental. When learners engage in deliberate practice, the improvement of skill is their primary source of motivation; learners are unlikely to feel motivated to persist in their efforts if practice does not lead to improvement. For Ericsson and his colleagues, defining the characteristics of deliberate practice and the practice activities of highly skilled performers is of paramount importance for both performers and educators alike.

Ericsson and colleagues’ work coincided with that of McPherson, a pioneer of research in self-directed music practice. In one of his earlier studies, McPherson (1996) noted experience-related differences in performance scores between two groups of high school-aged trumpet and clarinet students on a battery of tests corresponding to various musical skills (e.g., playing from memory). In an effort to explain these differences, McPherson examined post-test interview responses in which the participants explained the strategies they used to complete the music memory test. Participants were asked, “Can you tell me exactly how you memorized that melody; what did you do in your mind as you studied the notation?” A content analysis of participants’ responses revealed eight distinct cognitive strategies that were used by participants to memorize the notated music. McPherson divided these strategies into two categories: instrument-independent (e.g., singing the melody inwardly without trying to connect the auditory image to how it is played on the instrument) and instrument-dependent (e.g., singing the notes with rhythm and pitch while fingering on their instrument). Sixty-six percent of the less-experienced participants (Group 1) reported using instrument-independent strategies to memorize the melody, whereas 67% of the more experienced participants (Group 2) reported using instrument-dependent strategies, suggesting that the participants in Group 2 had developed stronger connections between abstract representations of music (e.g., notation) and the physical actions required to realize those representations on their instrument.

Learners' use of such cognitive strategies played a central role in the development of the theory of Self-Regulated Learning (SRL) in music (see McPherson & Zimmerman, 2002) which continues to serve as a leading theoretical framework for the study of self-directed music practice, particularly that of developing musicians. McPherson, Osborne, Evans, and Miksza (2017) tested a newly-developed three-phase microanalysis protocol to study self-regulated learning of two undergraduate piano students of differing skill levels. Each phase of the microanalysis protocol corresponded to one of the three phases of SRL (Forethought, Performance, and Self-Reflection), in which participants responded to questions designed to elicit information about their behavior, cognition and affect (feelings) before, during and after practice. In the performance phase, the pianists viewed video-recordings of their practice session and described aloud what they remembered thinking about at various moments in the recorded practice session. The pianists' verbal responses described attention to both the physical (e.g., "trying not to lift the fingers too high," p. 27) and auditory (e.g, achieving contrast between left hand slurring and right hand more staccato-like," p. 27) features of the repertoire. Compared to the less accomplished pianist's responses, the more advanced pianist's responses were generally more positive in affect, and her practice behaviors and strategies were more sophisticated and effective, as determined by the microanalysis instrument.

Miksza, Blackwell, and Roseth (2018) applied a similar microanalysis protocol to measure the self-regulation tendencies of three undergraduate music majors during practice. The authors' secondary purpose was to design an intervention using the measurements obtained by the microanalysis protocol to increase the self-regulation tendencies of the three participants as they practiced over a span of 15 consecutive days. In the performance phase, all three participants described thoughts (see Miksza et al., 2018; Table 2) focused on a wide variety of physical (e.g., "relax [the] embouchure) and auditory (e.g., "trying to connect registers with uniform sound") components of performance, as well as relationships between the two (e.g., "[using] fast and consistent airflow when connecting notes"). Comparison of baseline and post-intervention microanalysis measurements indicated modest improvements in the participants' SRL tendencies.

The studies described so far in this section on self-directed practice relied extensively on the retrospective accounts of participants that were provided after practice had ended. In their investigations of artist-level musicians' practice, Chaffin and his colleagues often incorporated both concurrent (e.g., participants reported their thoughts aloud intermittently between practice trials) and retrospective accounts (Chaffin, 2007; Chaffin & Imreh, 1997; Chaffin & Imreh, 2002; Chaffin, Imreh, Lemieux, & Chen, 2003; Chaffin, Lisboa, Logan, & Begosh, 2009; Chaffin & Logan, 2006). In one study, Chaffin and his colleagues (2009), describe how a concert cellist (the second author) prepared and memorized the Prelude of J.S. Bach's *Suite No. 6* for a series of public performances. Over the course of the video-recorded practice sessions, the cellist was encouraged to talk to the camera occasionally to explain what she was doing and thinking about. She also provided retrospective accounts at the conclusion of each session in which she described specific aspects of the music she thought about during practice, including performance cues (e.g., features attended to during performance), musical structure, and decisions about technique and interpretation. Analysis of both the concurrent and retrospective accounts, as well as the cellist's written recall of the memorized score, revealed memorization strategies built upon the features and hierarchical structure of the piece itself. Interestingly, the performance cues that constituted the lowest level of hierarchical organization included attention to both physical (e.g., fingerings and hand position) as well as expressive or interpretive components (e.g., tempo changes). Upper hierarchical levels, however, were organized almost exclusively on expressive and structural features of the piece. Changes in the observed structure of the cellist's practice sessions reflected this hierarchical organization as well; that is, the cellist focused on the rehearsal of lower hierarchical levels in the earliest practice sessions, gradually assembling these smaller segments into larger, more cohesive sections as sessions progressed.

Unlike the studies described heretofore, Duke, Simmons and Cash (2009) explored the self-directed practice of advanced pianists through a purely behavioral lens. Seventeen graduate and advanced-undergraduate pianists learned to play a short but technically-challenging two-handed passage with instructions to practice until they could play the excerpt confidently at a prescribed tempo. There was no time limit on the practice session. Participants returned a day later for a retention test in which they performed 15 trials of the same passage at the prescribed tempo. All practice and retention test trials were video- and audio-recorded. The authors reviewed each participant's practice session, recording and categorizing each pianist's practice behaviors. The authors then ranked each participant from highest to lowest based on their overall performance quality across all 15 retention test trials. The top performers at the retention test were those whose practice behaviors were classified by the authors as being directed at detecting and correcting errors. Specifically, these participants consistently and accurately identified the location or source of an error, manipulated the tempo of the excerpt advantageously, and repeated target passages until the error was corrected during practice. Interestingly, the top-ranked participants at the retention test did not make substantially fewer errors than the other participants at the beginning of practice but, instead, were more adept at locating errors precisely and correcting them efficiently. Altogether, these results also suggest that effective practicers are attending to their performance in such a way that errors can be swiftly identified and corrected, perhaps as a combined result of clear mental representations of a target performance (i.e., imagining how the passage should sound and feel) and well-learned relationships between physical actions and their auditory outcomes.

Though these studies have contributed to our understanding of self-directed practice in recent years, little is known about how learners of all ability levels think about discrete components of performance (e.g., intonation, the motion of the hands) in the absence of a teacher's guidance, particularly among learners in the earliest stages of learning a new instrument.

SUMMARY AND RESEARCH QUESTIONS

The evidence supporting the benefits an external focus of attention during performance in a variety of skill domains appears to be conclusive. However, when contemporary models of motor control and the complexity of naturalistic instruction are taken into account, it is clear that we still have much to learn about the influence of attentional focus on music learning. Surely, a deeper understanding of the role of focus of attention, both in the contexts of group instruction and self-directed practice, would be of great benefit to practitioners and learners alike.

In this dissertation, I report the findings of three studies. The first is a small-scale case study of two skilled teachers in their beginning (6^{th} grade) band classrooms that catalogued each teacher's internally- and externally-focused verbalizations. The second study expanded the case-study design of the first study by including a third teacher and increasing the number of observations on each campus so that teachers' verbalization behaviors could be documented across one semester. The third and final study investigated the internally- and externally-focused verbalizations of undergraduate music education majors who were asked to describe aloud what they were thinking about during self-directed practice on a secondary brass instrument. Together, these three studies were designed to answer the following research questions:

How do teachers direct their students' attention to specific internal and external elements of performance during instruction in music classroom settings?

How do students focus their own attention on specific internal and external elements of performance during self-directed practice?

What are the variables that influence how teachers and students focus attention on internal or external performance components?

How can teachers and learners manipulate attentional focus in order to optimize learning and performance from the beginning stages of music study?

Chapter 2: Analysis of Teachers' Internally- and Externally-Focused Verbalizations in Beginning Band Classrooms

Empirical evidence supporting the adoption of an external focus of attention during performance is extensive. For instructors in a variety of disciplines, this is paradoxical in a way, because focused attention on physical components of performance so often seems to yield positive results. Thus, there is an apparent rift between the recommendation of researchers and the practical knowledge of teachers, particularly for those in beginning band classrooms where an emphasis on fundamental, physical aspects of performance is not only typical, it is critical to students' success. Surely, music teachers in a variety of contexts provide ample opportunities for beginners to focus on external elements such as tone quality, timing, and expression. How and when do teachers make these choices, and what variables (e.g., instructional contexts) influence these decisions?

The purpose of this study was to analyze the verbalization behavior of two experienced band directors in order to describe the manner in which they direct students' attention during ongoing group instruction. I video-recorded two experienced band directors in their beginner (6^{th} grade) classes (approximately 50 minutes each) and completed a content analysis of the videos in order to: 1) document music teachers' verbalization behaviors, and 2) categorize teachers' verbalizations based on their intent to focus learners' attention on either internal or external elements of performance.

METHOD

After obtaining Institutional Review Board (IRB) approval, I solicited recommendations from local professionals and considered colleagues' field observations of area teachers to identify potential participants. The two directors who participated (both self-identified females) were known as skillful beginning band teachers in the greater metropolitan area of Austin, Texas (see Table 2.1 for descriptive information); both agreed to participate, gave informed consent, and were naïve to the purpose of the study. Pseudonyms were created for each teacher. The 50-min classes observed were selected primarily by scheduling convenience; they were homogeneous beginner classes on flute and trumpet, consisting of roughly 15-20 students each. Demographics for the students enrolled were similar on both campuses, and both schools were located in suburban areas.

I observed both participants teaching complete classes in the spring (second) semester of the beginner (6^{th} grade) year. Recordings were made using a digital video camera trained only on the teacher for the purposes of IRB compliance. Using SCRIBE software (Duke & Stammen, 2011), I analyzed 93 minutes of video documenting 373 instructional verbalizations. Non-instructional teacher verbalizations addressing basic classroom logistics (e.g., "Pass your t-shirt forms to the right.") and social redirection (e.g., "Eyes on me, please.") were excluded from the analysis. SCRIBE behavior categories and codes were created in accordance with my research questions: General Verbalizations included questions, directives, and feedback statements, and Specific FOA Verbalizations included specific internally- and externally-focused directives and feedback statements. Although performance-related questions posed to the students were included in verbalization totals (see Table 2.1), I chose not to include them in the more specific FOA verbalization categories. Questions alone did not appear to clearly elicit changes in student performance, but were instead intended to either frame a brief discussion of performance issues or provide a context for subsequent teacher directives or feedback statements.

Table 2.1

Participant information and descriptive statistics for performance-related verbalizations

	Gloria	Melissa
Participant information		
Years of experience	21	12
Primary instrument	Horn	Flute
Class observed	Trumpet	Flute
Total performance-related verbalizations (*n*)	158	215
Verbalization proportions (%)		
Directives	50.0	70.7
Positive feedback	25.3	17.2
Negative feedback	9.5	4.2
Questions	15.2	7.9

A faculty member with 19 years of experience in beginning instrumental instruction served as a reliability observer. Watching both videos, we independently coded the teachers' verbalizations and compared our observations to resolve any disagreements and refine operational definitions when necessary.

Once the content analysis was complete, I visited the teachers again to conduct brief semi-structured interviews. After acquiring basic information (e.g., years of teaching experience in beginner classrooms), I asked participants to describe their general approach to beginner instruction, both in terms of lesson planning and their decision-making in the classroom. I also asked them to discuss their thinking about internal (physical actions) and external (auditory outcomes) components of performance in terms of students' skill development. I then provided an overview of the FOA phenomenon (i.e., the *constrained action hypothesis*) and explained the purpose of the study. The interviews concluded with more extemporaneous discussion in which I asked teachers to react to the FOA information, both generally and in terms of their own classroom teaching.

RESULTS & DISCUSSION

General Teacher Behaviors (Question 1)

The frequencies of both teachers' general verbalizations were largely consistent with Worthy and Thompson's (2009) analysis of beginning band instruction (see Table 2.1). Directives were more common than feedback statements for both Gloria and Melissa, and feedback was predominantly positive in nature, as these teachers deliberately used directives in lieu of negative feedback at this stage of young musicians' development.

I observed notable differences in the two teachers' approaches to classroom instruction. Gloria delivered substantially fewer verbalizations than Melissa, which I attribute to Gloria's abundant use of modeling to convey information to students. Gloria modeled on her instrument consistently throughout the class, which she often paired with relevant directives (e.g., "Make sure your bottom lip is firm."). She also provided vocal models that included pitch and style information as well as other cues such as note names or rhythm syllables (i.e., counting systems). Melissa modeled most during warm-up and skill building exercises in the first half of the recorded class, particularly when certain exercises or passages involved challenging fingering combinations. In these scenarios, she often held her flute in view of the students, modeling the fingerings while cuing upcoming note names aloud.

It is also possible that the frequency of verbalization types was influenced by other factors such as class size and the instrument being taught. Melissa's flute class was larger (approximately 20 students) than Gloria's trumpet class (approximately 15 students), which may explain the higher number of directives delivered by Melissa. A greater quantity of verbalizations would be required to provide adequate directives and feedback to a larger group of students. It was clear that Melissa made a concerted effort to provide individualized instruction over the course of the recorded class; on several occasions, she changed her position among the students, listening and responding to individual student performances. The bimanual complexity of the flute itself (relative to the trumpet) may have also contributed to the higher overall frequency of Melissa's verbalizations.

Both teachers were judicious in selecting when they would speak during a student performance trial, with the majority of verbalizations occurring between trials rather than during trials. This seems logical when one considers the cognitive demands imposed on inexperienced learners who are actively playing their instrument. The infrequent mid-trial verbalizations I observed were often brief and intended to cue or remind students about some upcoming feature of the task at hand (e.g., “F-sharp, second finger!”).

Specific FOA Verbalizations (Question 2)

Of both teachers’ combined total of 373 instructional verbalizations, I identified 96 directives and feedback statements (25.74% of all instructional verbalizations) as having a clear intent to focus students’ attention on specific internal or external elements of performance. This proportion was surprisingly small, but may have been artificially low as a result of the relatively broad operational definitions I used in this study. This and other concerns will be addressed below.

Table 2.2

Specific FOA verbalization data

	Gloria	Melissa
Number of verbalizations	36	60
Specific FOA verbalization proportions (%)		
IF directives	63.9	68.3
EF directives	16.7	6.7
IF feedback	8.3	18.3
EF feedback	11.1	6.7

Specific FOA verbalizations were predominantly internal in nature (see Table 2.2) and were most often expressed in the form of a directive. For example, during an octave slur exercise, Melissa cued her students to use "…nice hot air on the lower tones." The higher frequency of IF directives seems reasonable given the nature of beginner instruction; because the performance of any musical skill requires the coordination of multiple physical components, teachers often identified several relevant internal targets (via IF directives) immediately preceding a performance trial. Furthermore, in the second semester of the beginner year, when fundamental posture, hand position, and tone production were well-established to a large degree, both teachers and students were engaged in the interactive process of simultaneously acquiring new skills while refining existing skills in both familiar and unfamiliar contexts. It is logical, then, that teachers continually focused their students' attention on relevant internal elements of performance to ensure that proper fundamentals were maintained.

EF verbalizations were relatively few and, therefore, no clear patterns emerged in terms of the instructional contexts in which they were delivered. There were, however, a few instances in which teachers' verbalizations explicitly *paired* a desired change in physical action with an improvement in some aspect of the students' sound. In Gloria's class, during rehearsal of a melody featuring both legato (slurred) and staccato articulations, EF feedback statements were more common, such as, "[You have to] clip the last note of the slur." She then pointed out to her students, "Finger-wise, this is not tough. It's all about what you're doing with your tongue and, of course, what you do with your sound." While such instances were not a common feature of the teachers' instruction, the pairing of action and outcome did appear deliberate, and *post hoc* interview data provided support for this idea (see below). Pairing behavior is a common feature of skilled teaching in a variety of instrumental contexts (Colprit, 2000, 2003; Duke & Simmons, 2006; Worthy & Thompson, 2009) as a means of building students' knowledge of action-outcome relationships on their instrument.

After completing the content analysis, it became clear to me that instances of instrumental and vocal modeling may have functioned in a manner similar to an EF verbalization in terms of directing student attention to external aspects of performance. Though it may not always be apparent to students what teachers are physically doing while modeling on wind instruments, teachers have an intuitive sense that some goals and outcomes can be more effectively and efficiently communicated via modeling. For example, Melissa's demonstration of fingerings described above (Question 1) was much clearer and more succinct than a verbal description of the correct fingerings would have been. Similarly, Gloria often cued her students to, "Sound like me," immediately prior to a performance trial. These observations, combined with *post hoc* interview responses, suggest that teachers may strategically employ modeling as a means of accomplishing instructional goals in the short term without calling specific attention to the myriad physical components involved in a given task.

Analysis of Interviews

Both teachers' responses during interviews suggest that, while neither teacher was explicitly aware of the concept of internal and external FOA, the trends observed in verbalization data were, at least in part, the result of deliberate choices on the part of the teachers. When asked how they view the distinction between internal and external components of performance, both Gloria and Melissa confirmed that, though music making is inherently defined by work toward auditory (EF) goals, the internal elements that support that work are a prerequisite and must be, to some degree, isolated for extended periods of instruction before significant emphasis can be placed on external outcomes.

Melissa's instructional strategies seek to make these internal components as clear and concrete as possible for her students, often through the use of mirrors and checklists. Melissa described this process in the context of a beginner brass class that she teaches:

> [We have] physical checklists that we do at the beginning of the year with all the physical goals so that they can see it…and we have mirrors so they can literally see those physical goals…and they can go down [the list] and [say], 'Oh yeah, I forgot to do this. My bottom lip wasn't lining up straight against my bottom teeth.'

Both teachers seemed curious about the idea of pairing internal and external verbalizations to convey action-outcome relationships. However, when asked to share their thoughts on this process, both readily provided examples of their own teaching behaviors that were intended to pair students' physical actions with their auditory outcomes. When asked about instances in which she explicitly pairs internal and external goals, Gloria responded:

> I probably do right at the very end, like when they do that physical thing… 'See [that] makes it sound more mature.' I use that phrase a lot, 'This makes it sound more mature. You sound more grown up now.'

Melissa described an example of pairing in which she asks a student to compare their performance to her own model, and how the physical checklists described above serve as a troubleshooting reference or guide: "…using the checklist, using the mirror, and then making the sound…going back and forth with the teacher. 'Does that sound like my sound? Well, why does it not? What's on your checklist that's missing?'"

As described in the previous section, a teacher model may act as a surrogate for externally focused verbalizations, particularly in scenarios when numerous physical components contribute to the accomplishment of a given auditory goal. When asked about the prolific use of modeling in her teaching, Gloria described the importance of a model when teaching musical style: "You know, when you get into style later on with them…you can explain staccato as much as you want to, but until you show it to them, they're not going to be able to play it accurately."

Melissa agreed that a model is often a more effective means of conveying information to students, but pointed out that the extent to which she models for students on a regular basis depends on the class and instrument being taught. She expressed concern about how this might have an impact on some of her classes in the long term: "…I always feel like my clarinet students are a little behind my flutes at the end of their sixth grade year, and I'm wondering if maybe that's not because I don't rely enough on the [auditory] part of it with them."

While it is unclear from the limited data acquired in the present study if trends or shifts in teachers' use of IF and EF verbalizations might occur systematically over time in the beginner year, both teachers reported feeling confident that EF verbalizations were not only more prevalent as students' skill level increases over time, but that externally focused goals were critical to students' musical growth as they approach 7th grade. Gloria, for example, explained that tone quality and independent reading skills are the two overarching goals in all of her beginner classes from the start of the year. Although not often explicitly stated to students, such goals might serve as what Duke (2005) describes as a "vision of students as accomplished learners," guiding work each day and throughout the year with these fundamental aspects of musicianship as the ultimate goal.

CONCLUSIONS & LIMITATIONS

After conducting a content analysis of two videos, one for each of two teachers in their beginning band classrooms, I found that these teachers most often conveyed performance-related information to their students via directives and focused learners' attention on predominantly internal elements of performance. In interviews conducted following my observations, both teachers indicated that this emphasis on physical skills and fundamentals was deliberate to some extent, serving as a foundation on which a repertoire of action-outcome pairings is built.

The present study serves as an initial descriptive examination of the role of attentional focus in beginning band instruction that is meant to inform future research design, and these results are an important first step in planning for future investigations that could delve deeper into our understanding of how attentional focus could be used as an instructional tool.

Because modeling was a salient feature of both teachers' approaches to beginner instruction, subsequent studies in naturalistic classroom contexts should explore students' responses to these teacher behaviors to determine whether modeling does indeed function as effectively as a specific EF verbalization in directing student attention to an auditory goal (EF). Also, I would like to develop an operational definition for instances when internally- and externally-focused verbalizations are paired together in order to convey a specific connection between actions and outcomes. For example, when non-specific feedback (e.g., "Good.") occurs immediately after a brief performance trial that was preceded by a specific IF directive (e.g., "Make sure your fingers move at the same time."), it could function as specific IF feedback if the student pairs the general assessment with her change in action. A more refined operational definition could identify instances of pairing based on the temporal proximity of the two verbalizations relative to an intervening performance trial.

The greatest limitation of the present study is the lack of data describing patterns or shifts in teachers' use of specific FOA verbalizations over time, both within a given class and across weeks or months of instruction. As noted in Question 1 above, Melissa modeled most during warm-up and skill building activities. It is difficult to say whether this pattern is a stable feature of Melissa's instructional approach, or simply the result of the day's planned activities. With repeated observations, clearer trends might emerge in terms of the contexts in which teachers strategically focus learner attention on either internal or external components of performance based on concurrent activities or instructional goals. Similarly, data from repeated observations might reveal shifts in the overall proportion of IF to EF verbalizations, or a change in the selection of FOA targets as students' skill level increases over the course of a semester or school year.

There is still much work to be done to increase our understanding of the effects of focus of attention on the acquisition and refinement of musical skill in group contexts. It could be that experimental protocols conducted outside of the classroom context are necessary to answer the questions raised by this study more deeply. As learners engage in the long process of skill acquisition and refinement, it could be that the most important role of a skilled teacher is to focus a student's attention on the most salient aspects of her own performance in a way that yields optimal results.

Chapter 3: An Analysis of Teacher's Internally- and Externally-Focused Verbalizations in Beginning Band Classrooms: Repeated Observations

As reported in Chapter 2, it is clear that teachers in beginning band classrooms focus student attention predominately, but not exclusively, on internal performance components during ongoing group instruction, and that they often explicitly state how physical actions (IF) relate to the sounds that are created (EF). Having only observed two teachers one time each, the question remained whether teachers' use of FOA verbalizations might change over time as instructional goals become more complex and students' skills improve.

To explore this possibility, we observed and video-recorded three experienced band directors teaching beginner (6th grade) brass and woodwind classes over the spring semester, and completed a content analysis in order to 1) categorize teachers' verbalizations based on the internal or external elements of performance they address, and 2) describe emergent patterns in the teachers' use of IF and EF verbalizations.

METHOD

After obtaining Institutional Review Board (IRB) approval, we began to identify participants by soliciting recommendations from local professionals and also considering our own field observations of area teachers. The three directors we chose (all self-identified females; range of teaching experience, 13-22 years) were known as skillful beginning band teachers in the greater metropolitan area of Austin, Texas; all agreed to participate, gave informed consent, and were naïve to our purpose and research questions.

Pseudonyms were created for each teacher; Beth was observed teaching clarinet (approximately 24 students), Gloria teaching trumpet (approximately 18 students), and Melissa teaching low brass (approximately 11 students). Both Beth and Gloria's classes were homogeneous, whereas Melissa's low brass class included trombone, euphonium and tuba students who had been selected by the band staff as needing remedial instruction. The classes we observed were determined primarily by the teachers' class schedule and our availability, and we were satisfied with the variety of context they offered. All three schools were situated in suburban areas and served student populations that were similar in terms of demographic characteristics.

Each participant was observed teaching complete 50-min classes three times, beginning late January and ending mid-April. Recordings were made using a digital video camera, and for the purposes of IRB compliance, the camera was trained only on the teacher. A wireless lapel microphone was attached to the teacher's clothing and a high-fidelity digital audio recorder was placed at the front of the room to record classroom sound. Later, these audio recordings were balanced and synced with the video recording, with balance biased toward the teacher's lapel microphone.

The first author completed one pilot observation on each campus in order to acclimate students to his presence prior to data collection, ensure recording quality, and refine the variables to be included in the analysis (see Table 3.1 for a list of variable categories and codes). We used SCRIBE software (Duke & Stammen, 2011) to code all teacher verbalization data, beginning with identifying performance-related verbalizations (i.e., those that were paired directly with students' performance on their instrument) and non-performance verbalizations (e.g., theory information, counting and clapping rhythms, discussion of administrative issues). Only performance-related verbalizations were categorized further for analysis. Additional coding indicated teacher verbalization type (feedback, directives, questions) and categorized specific FOA verbalizations (internal focus, IF; external focus, EF). IF verbalizations were defined as those that draw attention to the body (e.g., fingers, embouchure, air), whereas EF verbalizations direct attention to movement effects or performance-relevant stimuli (e.g., tone, instrument, notes). FOA targets, defined as specific components of performance expressed in IF and EF verbalizations, and classroom activities (warm-up, skill building, repertoire) were also documented. Although teachers' use of questions were included in verbalization coding, we chose not to include them in the more specific qualifications (IF-EF and FOA target data). Questions were often not pointed enough to warrant categorization (e.g., "What did you think of that [performance trial]?"), and if they were specific, questions tended to serve as prompts that initiated and elaborated discussion rather than cues that prompted attentional direction immediately preceding a performance trial.

Table 3.1

Variables included in the SCRIBE analysis

Verbalization categories	Codes
Performance-related verbalizations	Directives, feedback, questions
Focus of attention	Internally and externally focused directives and feedback
Specific FOA targets	Internal: air, embouchure, fingering, foot tap, hands, oral cavity, posture, tongue External: counting, instrument, intonation, matching, note starts/stops, note duration, note shape, note names, note accuracy, rhythmic alignment, style, timing, tone, volume

The first author then selected one excerpt (9-10 min in duration) from each of the nine videos that comprised 20% of total recorded time, and created transcripts of those performance-related FOA verbalizations for reliability coding. The second author and a band director (with 22 and 12 years of beginning instrumental teaching experience, respectively) served as reliability observers. They independently coded each specific performance-related FOA verbalization in the transcripts as being either internally or externally focused. Reliability was calculated by dividing the total number of agreements by the total number of decisions, yielding a result of .96 between both authors and between the first author and the band director.

RESULTS & DISCUSSION

First, it is important to note that all three teachers demonstrated behaviors that were consistent with Worthy and Thompson's (2009) descriptions of skillful beginning band instruction. Although we confirmed this by collecting data regarding time use, modeling, and goal accomplishment in addition to what follows, we have not included all of that information here in order to focus on the verbalization data that are directly related to the research questions in this study.

Verbalizations and Focus of Attention (Question 1)

The first author analyzed 431 minutes of video documenting 2,349 total verbalizations, of which 1,366 were performance related. Table 3.2 displays the mean frequency (i.e., number) of total performance-related verbalizations made by each teacher and the mean frequencies of verbalization types. All participants used directives far more than other types of verbalizations, but only Gloria and Melissa delivered more feedback than questions. Beth's tendency to ask questions that engaged students in generating their own feedback are reflected in her data.

Table 3.2

Frequency means for performance-related verbalizations and verbalization types

	Overall	Beth	Gloria	Melissa
Total performance-related verbalizations	193.11 (51.86)	175.67 (60.87)	160.67 (24.58)	243.00 (26.06)
Directives	93.22 (30.04)	95.33 (28.57)	66.67 (21.20)	117.67 (19.55)
Feedback	60.22 (27.15)	29.33 (14.01)	64.00 (11.14)	87.33 (8.50)
Questions	39.67 (18.21)	51.00 (23.64)	30.00 (10.82)	38.00 (17.69)

Note. Overall means reflect all teachers' verbalizations across the nine videos. Teachers' means reflect their verbalizations across all three videos. Standard deviations appear in parentheses.

Mean frequencies (i.e., numbers) of IF and EF verbalizations are presented in Table 3.3. Nearly half of all verbalizations were IF directives whereas EF directives were less frequent. Because directives typically precede performance, it seems logical to direct beginners' attention to the physical motions they need to execute. Air, embouchure (IF), and tone quality (EF) were among the most frequent FOA targets for all teachers. One of Melissa's EF directives to her beginner low brass students focused their attention on tone: "You have to keep thinking as you play along, 'How beautiful does this sound?'" In contrast to directives, feedback statements delivered subsequent to performance were predominately externally focused. This also seems intuitive, as EF verbalizations often direct attention to performance outcomes.

Table 3.3

Frequency means for specific internally (IF) and externally (EF) focused verbalizations

	Overall	Beth	Gloria	Melissa
Total FOA verbalizations	114.11 (43.27)	106.00 (32.08)	79.00 (24.06)	157.33 (33.62)
IF directives	56.22 (22.54)	57.00 (26.91)	38.33 (11.59)	73.33 (15.95)
EF directives	24.89 (9.74)	28.00 (4.58)	13.00 (2.65)	33.67 (3.06)
IF feedback	13.11 (8.67)	7.67 (5.51)	10.00 (4.36)	21.67 (9.07)
EF feedback	19.89 (9.51)	13.33 (4.16)	17.67 (8.14)	28.67 (9.50)

Note. Overall means reflect all teachers' IF and EF verbalizations across the nine videos. Teachers' means reflect their IF and EF verbalizations across all three videos. Standard deviations appear in parentheses.

When we examined how verbalizations functioned in the classroom, we identified a total of 250 instances (across all 9 videos) in which IF and EF verbalizations were paired to convey an action-outcome relationship; in other words, teachers focused their students' attention on the body (IF) and connected the changes they asked for with the external effects they produced (EF). For example, Gloria addressed the technical fluency of a large leap by first modeling the skill on her trumpet, then directing her students' attention by saying, "Listen to how smooth that was" (EF). She modeled again and said, "We have to do this [points to embouchure], and this [points to abdominal muscles], and this [moves her second finger as if manipulating a valve]...at the same time" (IF). This suggests that in the early stages of players' development, teachers understand—even if implicitly—the importance of *pairing* changes in action with the outcomes they produce so students will begin to form these associations correctly and efficiently. Pairing behavior is consistent with other observations of skillful teaching in a variety of instrumental contexts (Colprit, 2000, 2003; Duke & Simmons, 2006; Worthy & Thompson, 2009).

Because multiple physical components are required to perform a given musical skill, it was not uncommon to observe teachers giving multiple directives regarding physical motion (IF) prior to performance trials. As described in the example above, Gloria paired simultaneous changes in the fingers, embouchure, and air (three IF directives) with the smoothness (EF) of a large ascending leap. Instances like this may explain the greater proportion of IF directives compared to other verbalization types (see Table 3.3), as this behavior was common among all three teachers.

Skillful teachers typically develop multiple response options for any given problem and base their choice of which to employ in the moment on what they think will work best for individual students and the class as a whole. For some skills, as with note accuracy, these teachers interchangeably (but not concurrently) used both IF (e.g., "That should be second finger, not first") and EF verbalizations (e.g., "That should be B-natural"). In other instances—particularly when students' physical habits were still developing—they tended to address the root of the problem (e.g., IF: "Take a full breath") rather than the outcome (e.g., EF: "Make sure your tone stays full all the way to the end of the note"). It is doubtful that these teachers made such distinctions consciously or deliberately, operating instead with an intuitive sense of when habit strength was sufficient to shift a student's focus away from their body (e.g., their breath) toward a relevant external element (e.g., note shape and duration).

Verbalizations were also often paired directly with instrumental and vocal models. Comments such as, "Do you hear how I sound different from you? OK, now sound like me" (Gloria), as well as the first example described above (the smoothness of the trumpet interval), were clearly meant to focus the students' attention on matching an auditory example (EF). These teachers often provided IF and EF directives before or after a model to clarify what they wanted students to focus on, and to help students discriminate between their own performance and that of the teacher. In this instructional context, modeling promotes an external FOA the same way that EF verbalizations do.

We also noticed occasional pairings between non-verbal physical cues and EF verbalizations, such as moving the second finger as if depressing a valve (IF) while saying to the euphonium players, "Remember to play an E natural (EF)!" It is unclear from our observations how these instances of combining an EF verbalization with a physical cue (IF) direct student attention, but these occurrences might be interesting to explore in the future.

Patterns in Teachers' FOA Verbalizations (Question 2)

In order to determine whether other variables might influence the way teachers direct their students' attention, we explored IF and EF data for patterns. First, we considered the idea that verbalization behaviors may change across the spring semester as students' skills improved. Second, we reasoned that teachers' verbalizations might change relative to the kinds of activities going on in each class. To explore these possibilities, IF-EF verbalization data were collapsed in two ways: by timepoint and classroom activities.

FOA Verbalizations by Timepoint

We analyzed all three teachers' FOA verbalization data by timepoint (Video 1, Video 2, Video 3) in order to assess whether IF-EF proportions changed as students' skill level improved. Our examination of IF-EF proportions at each of the three timepoints revealed that the three teachers remained remarkably consistent across the spring semester. Even though students' skill level improved as weeks passed, these teachers persisted in drawing their students' attention to the physical components of music performance most often.

FOA Verbalizations by Classroom Activities

We then combined data from the three videos collected for each teacher and tabulated the FOA verbalization frequencies that occurred during each activity type we observed (warm-ups, skill building exercises, technically demanding repertoire, and less technically-demanding repertoire) to determine whether teachers focused students' attention based on what they were playing in the moment (see Table 3.4). All three teachers clearly focused their students' attention on internal elements of performance during warm-up activities such as mouthpiece buzzing or small piece (e.g., mouthpiece and barrel) playing and long-tone work. Similarly, IF verbalizations were prevalent during skill building activities, such as developing flexibility, expansion of range, and refining technique. Drawing attention to the body (e.g., playing position, air, embouchure) as playing sessions begin is logical and likely reflective of the thinking that underlies skillful musicians' practice behavior.

Table 3.4

Proportions of internally (IF) and externally (EF) focused verbalizations according to classroom activity

Classroom activities	Beth		Gloria		Melissa	
	IF	EF	IF	EF	IF	EF
Warm-up	74.4	25.6	65.5	34.5	73.2	26.8
Skill building	74.8	25.2	64.9	35.1	67.7	32.3
Technically demanding repertoire	-	-	61.1	38.9	71.7	28.4
Less technically demanding repertoire	23.3	76.7	67.9	32.1	-	-

Note. Proportion data are percentages of each teacher's specific verbalization total for all three videos. Dashes appear in cases where our observations did not capture a particular type of activity.

When classroom activities shifted to repertoire, we found differences in the way these teachers focused their students' attention; for this reason, we explored these data based on the first author's perceptions of repertoire difficulty relative to student ability. Melodies were documented as being "less technically demanding" when students were able to play the melody from beginning to end and negotiate any technical demands with relative ease. When lengthy sequences of instruction preceded melodic performance and the quality of students' playing was quite variable, repertoire was documented as being "technically demanding."

Beth only selected repertoire that was well within her students' technical capacity and music reading ability. As students played melodies in class, Beth's verbalizations were predominantly external in nature (76.67%), such as, "Abby sounds really bouncy. Let's match what she's doing." In another instance, as students performed a simple melody in the style of a lullaby, Beth led the students through an extended questioning exercise where they decided how the musical effect could be accomplished while maintaining the shape of the melodic line. Beth's final directives were, "Play again...we'll do it slowly, you'll play it smoothly, and you'll not let the notes in the chalumeau (A4) pop out because they have less resistance." As Wulf and colleagues' constrained action hypothesis suggests (Wulf et al., 2001), Beth's students were likely able to recruit well-learned—perhaps automatized—skills in these less technically demanding scenarios that promoted their ability to focus on creating external effects.

Our observations of Gloria's classes, on the other hand, featured a relatively balanced selection of repertoire that included differing levels of technical demand. Interestingly, her proportion of IF-to-EF verbalizations remained relatively consistent during warm-ups, skill building activities, and repertoire, regardless of the technical demands each activity placed on the students. This feature of Gloria's teaching may be attributed to strong habits she has developed across the length of her experience teaching beginners (22 years), or perhaps to the nature of beginning brass instruction as compared to woodwinds.

Although Melissa selected repertoire appropriately (i.e., music that was technically achievable in the short term) for her remedial low brass class, the students continued to struggle with challenges that stemmed from their limitations in fundamental tone production rather than the music itself. For example, Melissa helped one of her tuba students play a fragment of a new melody with a characteristic sound (which also increased his note accuracy) by focusing his attention on the physical (IF) components of producing a resonant tone: "That sounds a little bit squishy...meaning that you're keeping your teeth really close together and you're mashing your lips...Let the *wind* vibrate your lips." Unlike Beth's students, whose automatized musical skills promoted an external FOA during the rehearsal of less demanding repertoire, Melissa's students were still in the process of developing these skills. Because her students required frequent cues and prompts that continuously directed their attention to the most fundamental, oftentimes physical, elements of music making, it is unsurprising that Melissa's IF-to-EF proportions were consistent across all classroom activities—none of the repertoire she had selected was easily playable by the students.

CONCLUSIONS & LIMITATIONS

This is the first study to describe how experienced teachers focus student attention on internal and external aspects of music performance in a naturalistic classroom setting. Across multiple observations in the spring semester, these three teachers directed learners' attention most frequently to internal elements of performance via directives. They tended to offer externally focused verbalizations in the form of feedback following student performance trials, and deliberately paired internal and external components from time to time.

While the predominance of internally focused verbalizations was consistent across all recordings, for one of these teachers, there was a clear shift in the proportion of IF-EF verbalizations relative to different classroom activities. When Beth's students were performing accessible melodies, she focused their attention on the external goals of music making considerably more than she focused on their physical actions. Although this pattern was not demonstrated by the other two teachers, the shift we documented in Beth's IF-EF proportions suggest possibilities for more systematic exploration.

Skillful music teachers regularly assess student performance on multiple internal and external dimensions (e.g., embouchure, breathing, tone, expressiveness) and must choose in the moment how best to guide students toward success in the short and long term. If teachers fail to provide paired IF and EF verbalizations, young music learners may struggle unnecessarily to associate physical movements with their outcomes and may misunderstand altogether which musical problems a teacher is trying to solve. These teachers demonstrated an intuitive understanding that students need to build a repertoire of action-outcome relationships that could serve as troubleshooting tools in students' independent work.

Our observation that teachers reliably focus their students' attention on both internal and external elements of performance is consistent with related observations of skillful music teaching, both in one-on-one contexts (e.g., Colprit, 2000, 2003; Duke & Simmons, 2006) and in ensembles (e.g., Cavitt, 2003), but it is inconsistent with the idea that directing performers to adopt an external focus of attention promotes optimal performance regardless of a learner's level of skill or experience (Wulf, 2016). The three teachers in our study were inarguably interested in improving student performance, but they were consistently focusing students' attention on *both* internal and external elements.

It is unsurprising that these teachers' instructional approaches did not align with extant experimental findings due to the differences between the laboratory tasks found in the kinesiology research and this descriptive study. First, our data are bounded by the limitations imposed by the multiple case study design. Second, our research questions demanded that our observations focus on teacher behavior rather than learners' performance. Here, we consider teachers' use of FOA verbalizations as they guide students' performance of multiple complex music skills across a four-month period, but in the kinesiology literature, experimental tasks are more clearly limited and are typically gathered over the course of a few days. Instead of comparing participants' performance under carefully controlled FOA conditions, our study is rooted in a naturalistic classroom setting where data describing student performance was unobtainable.

Our data suggest that teachers are intuitively focusing student attention on the body throughout the beginner year, but that they also begin pairing actions with outcomes in order to teach students how to make those associations independently. As beginners make rapid improvements in the control and execution of the fundamental motor skills required to perform beautifully, they likely develop a level of automaticity (Ruitenberg, Abrahamse, & Verwey, 2013) that allows them to direct attention away from the body (Wulf et al., 2001) and onto listening and thinking like a skillful performer. But what approach should classroom teachers take when they introduce new skills or ask students to apply a previously learned skill in a more sophisticated context? Would it then be more beneficial to use FOA verbalizations that direct student attention more internally? Future research could elucidate how teachers might advantageously direct students' attention throughout this learning process as it unfolds over time and performers' skills develop more fully. Perhaps the most exciting prospect for this line of investigation lies in the efficacy of promoting an external FOA as a gateway to learner autonomy, decision-making, and critical thinking.

Chapter 4: An Examination of Learners' Internally- and Externally-Focused Verbalizations During Self-Directed Practice

Learners' first experiences playing a new wind instrument are most often structured and guided by a teacher; the teacher selects appropriate exercises and repertoire and offers feedback and directive statements that clarify for students which actions are likely to produce the best outcomes. At some point though, the student must play and *think* independently, making their own assessments and choices as they practice alone. During self-directed practice, learners are confronted with the task of assessing their own performance outcomes and troubleshooting with whatever limited knowledge of the instrument they have acquired, wondering, "Why do I sound like *that*?" Teachers have acquired extensive knowledge of action-outcome relationships over years of experience performing and providing instruction—students, most often, have not. How do learners untangle their problems in their teacher's absence? Which components of performance are salient in their thinking?

In the beginning, students working alone must learn to manipulate the instrument, discovering how their body's movements create changes in the sounds they produce, often through a process of trial-and-error. Thus, it is logical that they think most about the physical components (IF) involved in playing the instrument to guide their work. But for how long is this kind of thinking advantageous? Is there a point in skill development when their attention should shift away from their actions and onto the quality of the outcomes they produce?

In this study, we examined undergraduate music education majors' self-directed practice on secondary brass instruments in order to describe: 1) students' perceptions of how they focus attention during individual practice, 2) the internal and external components of performance students report thinking about during active practice, and 3) whether a relationship exists between FOA and both prior training and overall performance achievement.

METHOD

Participants and Procedures

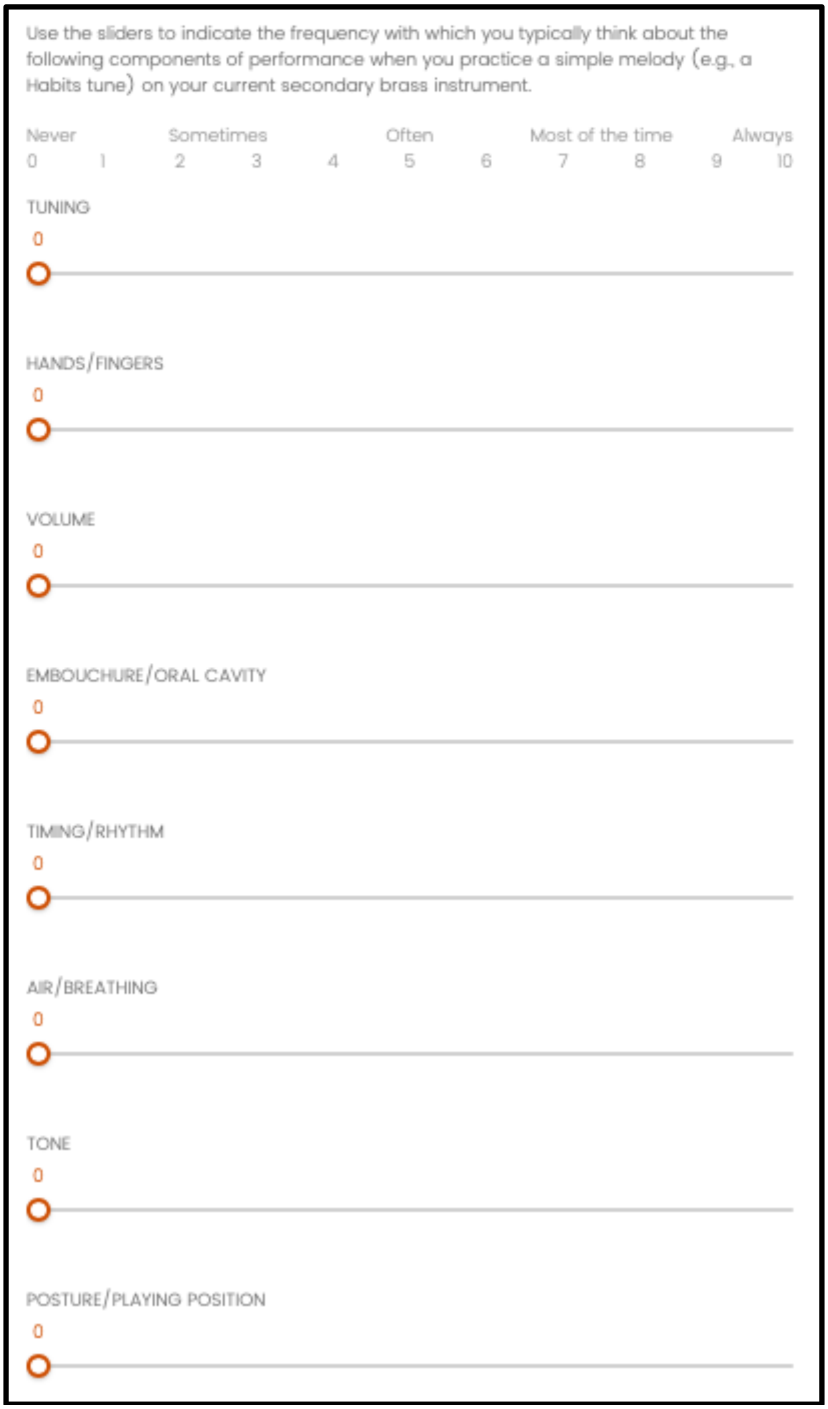
Participants were sixteen (*N*=16) students enrolled in an undergraduate brass methods class in Spring 2020. The class comprised music education majors who were primary brass (*n*=3), woodwind (*n*=5), and string (*n*=1) players, vocalists (*n*=5), and percussionists (*n*=2). In March 2020, all course instruction for the remaining six weeks of the semester migrated online in response to the COVID-19 pandemic. Just before the shift to online instruction, each student had been assigned a secondary brass instrument, with which they had had little or no experience, to study for the remainder of the semester: trumpet, trombone, or euphonium. As part of the online curriculum adjustments, students were assigned a Think Aloud (TA) project that required them to submit video-recorded performances in Weeks 2, 4, and 6 from which data for this study were extracted (hereafter these three assignments are labeled TA1, TA2, and TA3).

From an instructional standpoint, the purpose of the project was to provide students with an objective record of their self-guided progress on an unfamiliar secondary brass instrument over the six-week period of online instruction, and to provide students with numerous opportunities to verbally describe discrete components of brass performance (e.g., embouchure, intonation) as they will when teaching future students in the classroom. Students responded to this online, self-guided learning context differently; for that reason, the number of students who completed each Think Aloud assignment varied (TA1, n=16; TA2, n=14, less 1 clarinetist and 1 cellist; TA3, n=14, less 1 clarinetist and 1 percussionist; 3 students enrolled in the course never completed any Think Aloud assignments).

The instructions for each of the three TA submissions were the same. Students first responded to a brief survey question regarding their perceptions of what they think about when practicing melodies on their assigned secondary brass instrument. They were then instructed to video-record themselves performing 10 trials of a selected melody, describing aloud what they intended to think about before each performance trial and what they remembered thinking about following each trial (for examples of similar think-aloud protocols, see Bergee, 2005; Colley, Banton, Down, & Pither, 1992). The melody "Steady Stream Gone Down" (from *The Habits of Musicianship*, Duke & Byo, 2010) was used in each of the three assignments so that students could make clear assessments of their progress over the 6-week period; this melody was selected primarily because of its accessibility to all students enrolled in the class. After practice ended, students indicated the extent to which their performance reflected their current level of skill on the instrument.

Using Qualtrics software, I designed a web-based survey that guided students through the procedure. The survey was tested on a computer, tablet, and smartphone to ensure functionality across platforms. Each Think Aloud survey began with a general overview of the procedure, followed by instructions on how to set up the student's video recording device, and how to retrieve a copy of the assigned repertoire for their instrument. Next, students were asked to indicate their perception of how often they typically think about specific components of performance (e.g., air, tone) using an animated slider interface (hereafter referred to as the Perception Scale, PS, see Figure 4.1) in response to the following prompt: "Use the sliders to indicate the frequency with which you typically think about the following components of performance when you practice a simple melody (e.g., a *Habits* tune) on your current secondary brass instrument." The horizontal position of each slider was assigned a numerical rating (0-10) corresponding to relative frequency. The components presented in the interface were: hands/finger, embouchure/oral cavity, air/breathing, posture/playing position (IF), and tuning, volume, timing/rhythm, and tone (EF). We chose to omit certain components from the Perception Scale interface that would not apply to all students (e.g., trombone slide, EF; articulation[1], IF). After completing the Perception Scale, students read the following instructions:

[1] The melodies found in *The Habits of Musicianship* (Duke & Byo, 2010) are written such that they can be played with or without articulation.


Use the sliders to indicate the frequency with which you typically think about the following components of performance when you practice a simple melody (e.g., a Habits tune) on your current secondary brass instrument.

Never		Sometimes			Often		Most of the time			Always
0	1	2	3	4	5	6	7	8	9	10

TUNING
0

HANDS/FINGERS
0

VOLUME
0

EMBOUCHURE/ORAL CAVITY
0

TIMING/RHYTHM
0

AIR/BREATHING
0

TONE
0

POSTURE/PLAYING POSITION
0

Figure 4.1. The Perception Scale (PS) interface.

"You will be prompted to play the melody 10 times. Prior to each repetition, you will describe these two things aloud:

...what you **remember** thinking about as you played the **previous** trial. Do your best to pair where in the melody you were playing when you were thinking about the particular elements of performance you mention. For example: 'That time, I thought about keeping my jaw still the whole time,' and/or, 'I was trying to sound resonant when I got to measure 2, beat 3.'

...what you **intend** to think about on the **next** repetition. Do your best to describe exactly where in the melody (e.g., throughout or specific places) your thoughts will be directed. For example: 'This next time, I'm going to think about playing in tune," and/or, "I'm going to think about keeping my air fast at the beginning.'"

Prior to the first performance trial, students were given instructions to describe what they intended to think about on the first trial[2]. Between all subsequent trials, students were presented with a concise reminder of the instructions (see above) to ensure that verbalization data were captured for each trial; also included were intermittent reminders to speak in terms of specific components of performance and to avoid self-assessment. At the conclusion of practice, students were presented with a 5-point Likert-type scale (hereafter referred to as the Self-assessment Scale, SAS) and responded to the following prompt: "Now that you have completed your practice of this melody, rate how well you think you played this melody today given your current level of skill (i.e., your

[2] In TA1, students were instructed to imagine the melody before declaring their intention.

own best playing).” Labels were provided for the 1st, 3rd and 5th points on the scale, respectively, as follows: “Much worse than my best”, “Somewhat like my best”, and “Very much like my best.” Each Think Aloud survey concluded with instructions describing how students should save their videos, label them, and upload them to the course’s online assignment submission portal.

Data Analysis

The quantitative data analyzed in this study were the Perception Scale mean ratings, the mean frequencies of students’ internally- and externally-focused verbalizations during practice, and Self-assessment Scale mean ratings. Using SCRIBE 5 software (Duke, 2020), we analyzed students’ video-recorded verbalizations during each of the three sets of 10 performance trials, coding statements that focused specifically on either internal (IF, e.g., embouchure) or external (EF, e.g., tone) components of performance. These decisions were made in a manner consistent with the methods of analysis reported in Chapters 2 and 3.

To establish reliability, the practice portion of nine videos were excerpted (three from each timepoint—Weeks 2, 4, and 6); these video excerpts contained 261 internally- and externally-focused verbalizations, which was roughly 20% of the 1,331 total FOA verbalizations recorded across all three Think Aloud assignments. The reliability observer was both an experienced brass teacher and performer (21 years teaching experience, 18 years professional performance experience). He watched these excerpts while viewing the corresponding list of verbalization codes in an open chronology window of SCRIBE and indicated whether he agreed or disagreed with the assigned code. The number of agreements was divided by the verbalization frequency total from these nine videos, yielding an agreement rate of .98.

We chose to explore these data in three ways. First, we present overall means that include all students enrolled in the class. Then, to explore the idea that prior training may affect the way students focus their attention, we arranged them by their primary area of applied study to create Primary Instrument (PI) groups: brass (n=3; a French hornist, a trombonist, and a tubist), woodwind (WW, n=5; a bassoonist, a saxophonist, and three clarinetists), and non-wind (NW, n=8; a cellist, two percussionists, and five vocalists). Our rationale for this grouping was based on the expectation that some aspects of students' prior music training would transfer to the secondary brass instrument to be learned. Students in the Brass group would have an immediate advantage when learning a new brass instrument via the transfer of fundamental tone production skills from their primary instrument. The WW group, though less experienced with the fundamentals of brass playing, are accustomed to controlling air, embouchure, and fingers to produce tones on a wind instrument. By comparison, there is far less transfer of skill between the NW groups' prior training and the instruments in the brass family.

Finally, we considered the possibility that a relationship between performance achievement and focus of attention may exist. In order to assess overall performance achievement, we created a representative sample of students' playing at the conclusion of the Think Aloud project (which coincided with the end of the six-week period of self-guided learning) by extracting the audio for performance trials 4 through 7 from each

TA3 video.[3] Each students' audio-only excerpt was randomly assigned a number. Two teachers with extensive experience as beginning brass classroom instructors (12 and 23 yrs experience) assessed the recordings[4] and assigned students to one of three Performance Achievement groups: the High-performing group (*n*=3) included 2 brass players and 1 NW; the Mid-performing group (*n*=6) included 1 brass player, 3 WWs, and 2 NWs; and the Low-performing group (*n*=5) included 1 WW and 4 NWs. Although the Performance Achievement groups were not markedly different from the Primary Instrument groups in terms of the students they comprised, we wanted to explore the possibility that this slight change in groupings might yield differences worth investigating, even if only at the individual student level.

We have limited the following presentation of data to descriptive statistics for several reasons, the primary concern being the relatively small number of students involved in the project from the beginning. Also, the number of students who fully completed each of the three TA assignments fluctuated, and the number assigned to each of the three Primary Instrument groups and the three Performance Achievement groups were quite small and unequal.

[3] Trials 4 through 7 were selected because trials 1, 2 and 3 were most likely to contain capricious errors as students reacquainted themselves with the melody, and performance trials 8, 9 and 10 were those most likely to be affected by physical fatigue or boredom with the repetitive task.

[4] Criteria for these decisions were based on the presence of consistent tone note-to-note, consistent intonation, note starts and releases, and between-trial consistency. Tone was assessed as much by consistency as by overall quality to account for the differences in recording procedures that were impossible to control under the circumstances.

RESULTS

Student Perceptions of FOA

Mean ratings on the TA1 Perception Scale for all students combined revealed that students' perceptions regarding their thinking during practice were balanced between internal components (*M*=6.13, SD=2.46) and external components (*M*=5.92, SD=3.03). These overall IF and EF Perception Scale means shifted very little from TA1 to TA3, (IF mean range, 5.39-6.13; EF mean range, 5.92-6.29). Similarly, Perception Scale means for individual IF and EF components changed only slightly across all three TAs (see Figure 4.2). The mean for volume (EF) component, for example, changed the most from TA1 to TA3 (mean increase of 1.30); even that difference is of little practical significance given the 10-point scale. There is a trend, though, that Perception Scale means for EF components increased over time while the means for IF components decreased.

Across all three TAs, students were consistent in the way they rated each of the eight components of performance presented in the Perception Scale interface, suggesting a prioritization in students' perceptions of the way they think during practice. Tone, tuning (EF), embouchure/oral cavity, and air/breathing (IF) consistently received the highest mean Perception Scale ratings from all students, which is unsurprising given the inextricable relationship between these internal and external components of performance.

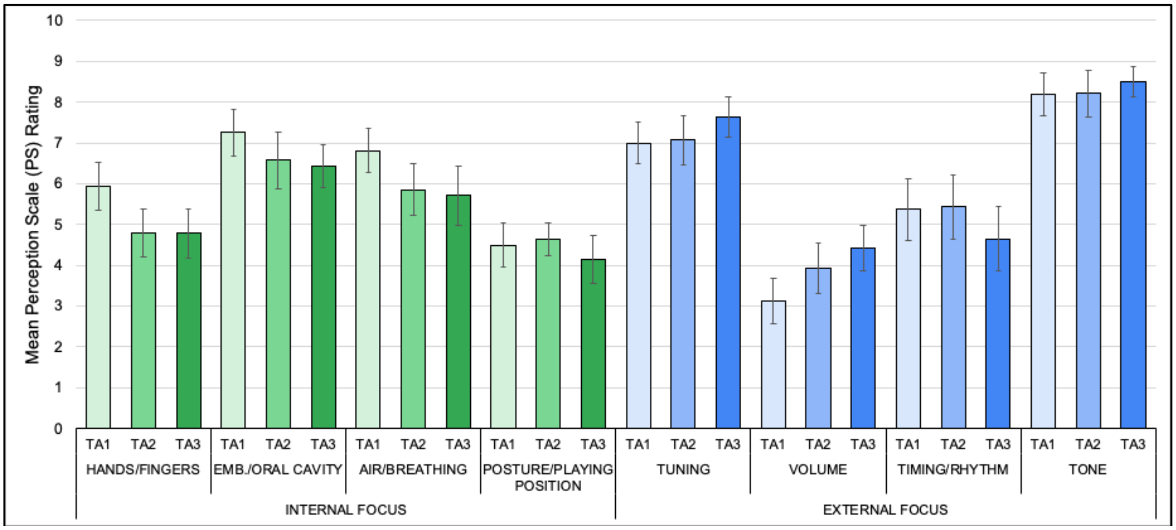


Figure 4.2. Perception scale (PS) means for all students by performance component. TA=Think Aloud. 0=Never, 10=Always. Error bars represent ±1 standard error of the mean.

FOA Verbalizations During Active Practice

Hereafter, we report the frequency of student verbalizations during active practice that correspond to the eight IF and EF components presented in the Perception Scale interface. It is important to note that students did report thinking about a few IF (e.g., articulation) and EF (e.g., phrasing) performance components during active practice that were not among those presented in the interface, but verbalizations referring to those components were infrequent across all three TAs. We include those data points in the overall IF and EF practice verbalization frequency means presented below, but do not discuss them further.

In TA1, the mean frequencies of students' specific practice verbalizations revealed that they reported thinking about internal (*M*=15.31, SD=8.01) and external (*M*=16.69, SD=5.79) components of performance relatively equally. This IF-EF balance remained somewhat stable at each of the three timepoints, with a mean range of 13.86 to 16.57 for IF components, and 12.93 to 16.69 for EF components. Tone, tuning (EF), air/breathing, and embouchure/oral cavity (IF) comprised the most frequently reported components of performance across the 6-week period (see Figure 4.3), which is consistent with students' perceptions of their thinking (i.e., highest Perception Scale ratings).

What is striking about these performance verbalization data is that the extent of difference between the mean frequencies for each performance component in both IF and EF categories is more pronounced than corresponding Perception Scale rating means predict. In other words, students' perceptions of their thinking during practice did not fully align with the frequency of their active practice reports for all eight components of performance. The most consistent result between the two measures is that practice verbalizations focused most frequently on tone (EF), air/breathing, and embouchure/oral cavity (IF), for which students' mean ratings on the Perception Scale were most closely aligned with the "often" or "most of the time" descriptors. Although Perception Scale mean ratings indicated that students perceived focusing on the other five components of performance "often," students' verbal reports during active practice did not align with their perceptions, particularly for hands/fingers, posture/playing position, volume, and timing/rhythm. A clear example of differences between perception ratings and verbalization frequencies is that students perceived thinking about both tone and tuning (EF) "most of the time" over the course of typical melodic practice, but when they actually practiced this TA melody, students reported thinking about tuning roughly half as often as tone.

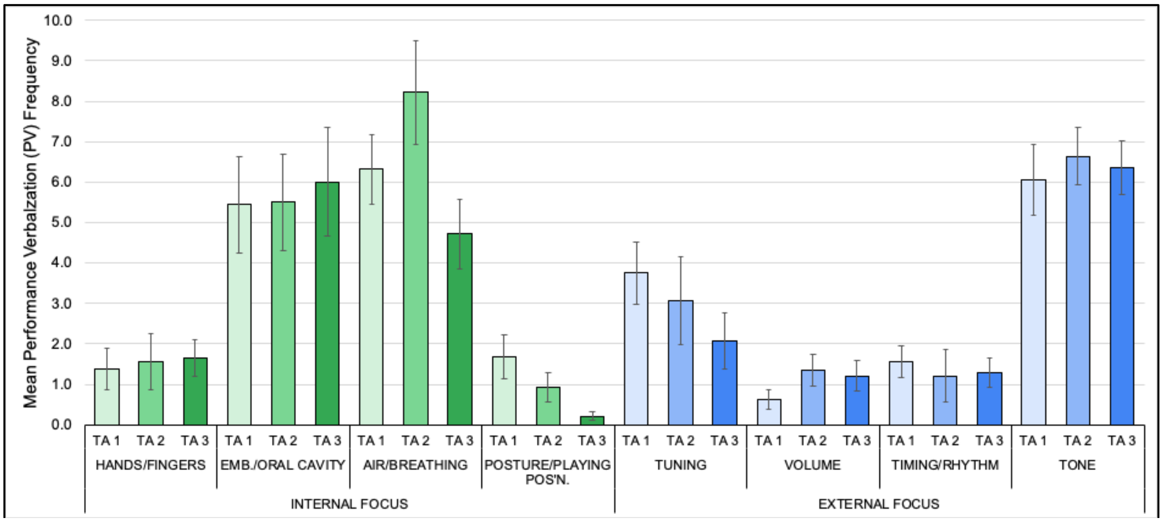


Figure 4.3. Mean performance verbalization (PV) frequencies for all students by performance component. Error bars represent ±1 standard error of the mean.

FOA and Prior Training

We examined mean Perception Scale ratings and practice verbalization frequencies for each Primary Instrument group (Brass, WW, NW) to explore the idea that students might attend to internal and external elements of brass performance differently depending on prior training. As expected, mean Perception Scale ratings (see Figure 4.4) for the Brass group at TA1 revealed an emphasis on external components (*M*=7.00, SD=3.13) over internal components (*M*=5.00, SD=2.86), and their perceptions of thinking were consistent over time. Mean Perception Scale ratings for the WW group were balanced between IF and EF at TA1 (IF *M*=5.40, SD=2.52; EF *M*=5.75, SD=3.06), but by TA3, the WW group's perceptions of thinking had shifted noticeably toward EF components. The NW group's Perception Scale mean rating for IF components (*M*=7.00, SD=1.97) was higher than for EF components (*M*=5.63, SD=2.97) at TA1, but their Perception Scale ratings in TA2 and TA3 were more balanced.

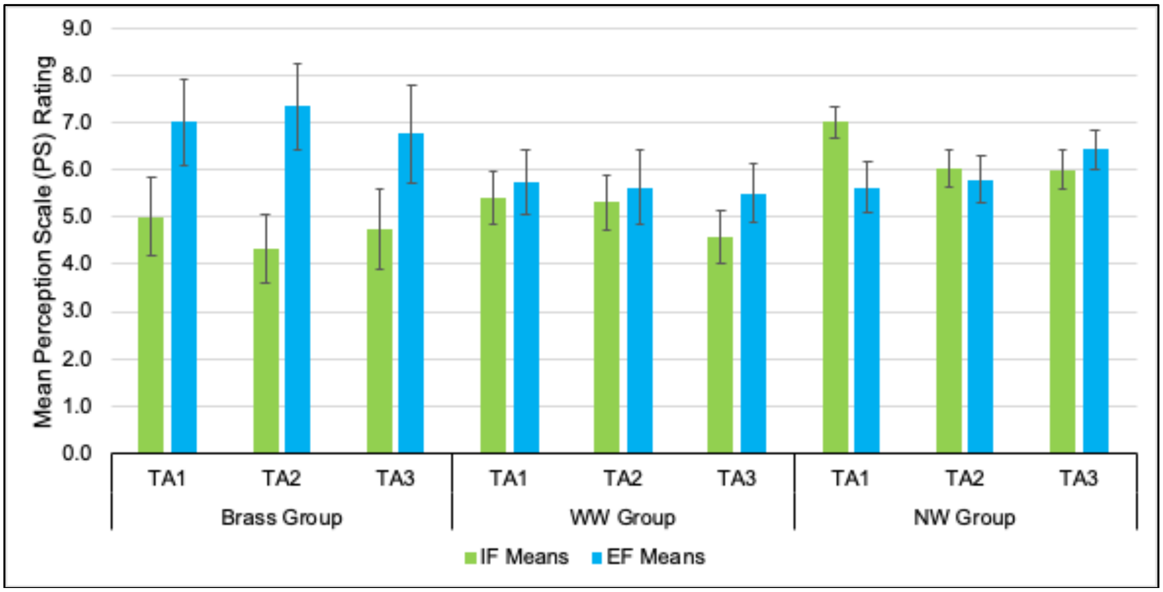


Figure 4.4. Mean perception scale (PS) ratings by primary instrument (PI) group. TA=Think Aloud. 0=Never, 10=Always. Error bars represent ±1 standard error of the mean.

Examination of each Primary Instrument group's internally- and externally-focused practice verbalization frequency means revealed similar trends (see Figure 4.5). The Brass group reported thinking about EF components (range, *M*=12.67-20.00) more frequently than IF components (range, *M*=7.00-15.33) in TA1 and TA3. The WW and NW groups' practice verbalizations were balanced between internal and external components across the 6-week period, with a notable exception in the WW group at TA3.

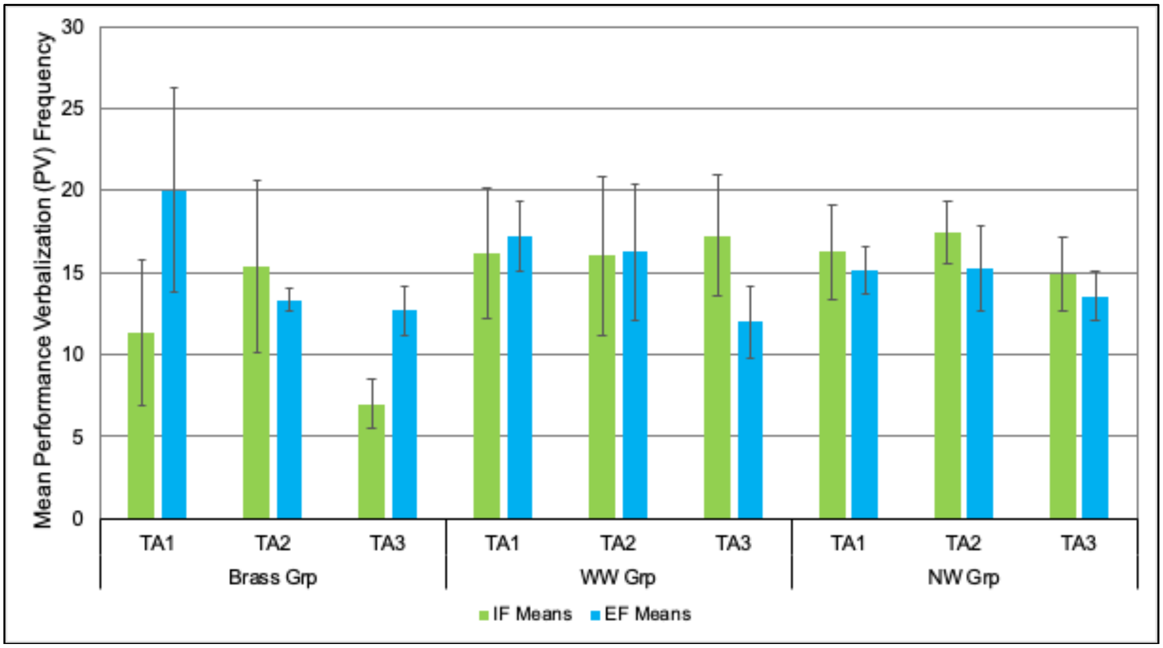


Figure 4.5. Mean performance verbalization (PV) frequencies by primary instrument (PI) group. Error bars represent ±1 standard error of the mean.

FOA and Performance Achievement

As described earlier, we grouped students by the level of performance achievement they demonstrated in Week 6. Our examination of Performance Achievement group means revealed that the High-performing group, like the Brass Primary Instrument group, tended to report externally-focused perceptions and verbalizations, whereas the Mid- and Low-performing groups demonstrated a relative balance between IF and EF on both Perception Scale and practice verbalization measures, a result that is consistent with the WW and NW Primary Instrument groups. What we found more interesting to consider were the data gathered from two students whose ultimate level of Think Aloud performance achievement did not align with what prior training would predict: Campbell, a percussionist who was learning euphonium (High-performing group), and Glenn, a tubist who was learning trombone (Mid-performing group).

These two students reported similar perceptions regarding how they typically think during secondary instrument practice, but they verbalized their thinking during active practice in substantially different ways that were not predictive of their ultimate performance achievement in TA3. Campbell's general perceptions of his thinking in practice and the frequency of his verbalizations during active practice reflected the relative balance of IF-EF components of performance demonstrated by the NW group overall (Campbell's practice verbalizations, IF: 48.72%, EF: 51.28%). Glenn's Perception Scale ratings tended to be more balanced between IF and EF components than were the Brass group's overall Perception Scale means, but his practice verbalization frequencies were predominately external in nature (Glenn's practice verbalizations, IF: 21.95%, EF: 78.05%) as were those of the other two students in the Brass Primary Instrument group who were considered high achievers.

Students' Self-assessment

Recall that the Self-assessment Scale asked students to assess their playing in each Think Aloud assignment relative to their current level of skill. Self-assessment Scale mean ratings for the class (i.e., all students) were moderately positive in TA1 and TA2 (i.e., "somewhat like my best"), and became slightly more positive by TA3 (see Table 4.1). There were interesting differences among Primary Instrument groups, though. Self-assessment Scale mean ratings for the Brass group were high in TA1, but decreased in

TA2 (-1.33 points on the 5-point scale) with no change in TA3. Mean ratings in the WW and NW groups were moderate in TA1 and TA2, but their mean ratings increased (+1.10 and +1.26, respectively) in TA3.

Grouping Self-assessment Scale ratings by Performance Achievement groups revealed that the High-performing and Mid-performing group means were consistent across all TA assignments; the High-performing group rated their TA performance as being close to their best playing relative to their current skill level, and the Mid-performing group rated their performance as being somewhat like their best. The Low-performing group's Self-assessment Scale mean ratings were the lowest of all three Performance Achievement groups for TA1 and TA2, but the Low-performing group's mean rating increased (+1.25) in TA3. Although students in the Low-performing group felt the least like they were able to demonstrate their best playing in the first two assignments, their notable mean rating increase for TA3 indicates that they felt more able to demonstrate their own best playing by the end of the TA project. It is also interesting to note that Glenn, the brass player assigned to the Mid-performing group, indicated self-assessment ratings that fell steadily across the 6-week period; in TA1, Glenn's rating was a 3 ("somewhat like my best") but in TA3, his rating was a 1 ("much worse than my best"), whereas Campbell's (the NW player assigned to the High-performing group) ratings rose steadily from a 3 at TA1 to a 5 ("very much like my best") at TA3.

Table 4.1

Means and standard deviations of self-assessment scale ratings by student grouping

	TA1 (*n*=16)	TA2 (*n*=14)	TA3 (*n*=14)
All students	3.38 (.96)	3.14 (1.10)	4.00 (1.18)
Primary Instrument groups			
Brass	4.33 (1.15)	3.00 (1.00)	3.00 (1.73)
Woodwind	3.60 (.89)	3.25 (.96)	4.50 (.58)
Non-wind	3.38 (.96)	3.14 (1.35)	4.14 (1.07)
Performance Achievement groups			
High-performing	4.33 (1.15)	3.67 (.58)	4.33 (.58)
Mid-performing	3.33 (1.03)	3.40 (1.34)	3.83 (1.47)
Low-performing	2.80 (.45)	2.75 (.50)	4.00 (1.22)

DISCUSSION

In this study, we examined how students learning secondary brass instruments focus their attention on internal and external elements of performance in the absence of a teacher's guidance. When asked about their perceptions of their FOA during routine practice, students reported thinking about predominantly external elements of performance (e.g., tone) at each of the three timepoints, but verbally reported thinking about internal elements of performance more frequently during active practice. These trends varied only slightly across timepoints and among Brass, WW, and NW Primary Instrument groups, with the brass students reporting perceptions and thoughts focused on external elements of performance more frequently than did the other groups. In general, self-assessment ratings indicated that students were increasingly satisfied with their performance over time; this was especially the case for the WW and NW students.

There were two exceptions to these trends. Recall that Campbell, a percussionist in the NW group, achieved high levels of performance by TA3 and reported focused attention on a balanced blend of IF and EF components in each of his three videos. Glenn, a tubist from the Brass group, focused on predominantly EF components throughout the TA project and achieved only moderate levels of performance. Analysis of each student's Self-assessment Scale ratings revealed that Campbell was increasingly satisfied with his ability to play at his best during active practice over time, and Glenn, unlike the other members of the Mid-performing group, grew progressively less satisfied with his ability to demonstrate his best playing over the course of the TA project. These findings suggest that prior experience may mediate the extent to which adopting a predominately external focus of attention is helpful during the early stages of complex skill development, even when the new context is relatively similar to a learners' prior experience. In Glenn's case, he may have negatively transferred some physical behaviors from his primary instrument playing to his secondary instrument learning, and would have benefitted from focusing his attention on the physical actions that were causing the issues that prevented him from playing at his best.

Our findings suggest that during self-directed practice, students think about discrete internal and external elements of performance differently depending on their level of related experience and prior training. This is inconsistent with findings in extant literature that make clear the benefits of an external FOA regardless of a performer's level of skill or experience (Wulf, McNevin, & Shea, 2001; Wulf, 2013). Interestingly, the NW students, for whom playing a brass instrument involved learning to control and coordinate physical movements that are quite different from those required by their primary instrument (including voice), reported general perceptions and thinking during practice that focused on internal components such as embouchure and air more frequently and consistently than did their peers in the Brass group. Students in the Brass group had well-developed (i.e., automatized) skills that transfer more readily to other instruments in the brass family, mitigating the need to deliberately focus attention on internal components.

It is equally important to make note of the performance components on which the students focused their attention less frequently. All students reported thinking about hands/fingers, posture (IF), timing/rhythm, and volume (EF) infrequently during active practice throughout the Think Aloud project. It is possible that the low frequencies with which students reported thinking about these components does not reflect the importance students place on them but, rather, the frequency with which students *need* to think about them. Each of these components constitute performance variables that are somewhat stable and require focused attention perhaps only at the beginning of practice, compared to other components like intonation, which require constant monitoring moment-to-moment during performance.

It could be that the development of automaticity does not spontaneously lead to learners directing attention away from internal components and toward external effects without being cued to do so (e.g., teacher's instructions). This would account for the absence of a substantial shift in FOA over time in both Perception Scale and practice verbalization measures during the six-week span of this project, especially considering that the task (the simple melody) never changed. Investigations of the manner in which the wording of instructions direct learners' attention to IF or EF components have repeatedly demonstrated the superiority of an external focus regardless of a learner's familiarity with the task (for example, see Totsika & Wulf, 2003). Nonetheless, we can confirm anecdotally that during self-directed practice, the WW and NW students in this study made significant improvements on their respective instruments while focusing their attention on both internal and external components relatively equally.

Recall that Campbell achieved a high level of performance relative to the other students in the class by adopting a balanced approach, focusing on both internal and external components throughout the Think Aloud project, and reported self-assessment ratings that steadily increased at each timepoint. Glenn reported adopting an externally-focused approach to practice, but his self-assessment ratings declined steadily over the six-week period. In this case, Glenn transferred the externally-focused approach he applies to his primary instrument practice to his learning of a new (but closely related) secondary instrument, which may have prevented him from progressing in a manner he deemed satisfactory.

While the overall ratio of IF and EF verbalizations remained relatively stable across the three TA assignments, there was a noticeable decrease in the frequency of certain IF and EF components (e.g., air and tuning) that the WW and NW students reported thinking about during practice, suggesting perhaps that as time passed, students began to “zero in” on which physical variables were *paired* more closely to the aspects of sound they wished to change, much in the same manner demonstrated by the teachers described in Chapters 2 and 3. One WW student, for example, made a clear statement to this effect at the conclusion of his TA3 video:

> “...rather than going with the most salient idea, I thought back to what I’ve been struggling with and thought, ‘Well, okay, let’s think about things that I can target in this time frame, in this context’...I’m able to think about those specific things. I also thought about how in this third Think Aloud, I was thinking more about specific aspects of the playing rather than saying, ‘Well, that should just get better.’”

The internally- or externally-focused nature of information performers receive via feedback can, alone, induce a corresponding shift in attentional focus (for example, see Wulf et al., 2002). It could be that while monitoring changes in external feedback (e.g., the sounds they produce), a learner’s motor system responds in a reflexive or automatic manner that might occasionally draw attention toward the body. It is possible that the students in this study may have only reported thinking about their physical actions (IF) even when those thoughts were generated by what they noticed in the sounds they were making (EF), particularly in the case of less-experienced learners (e.g., WW and NW groups). The more experienced learners in the Brass group may also have thought about their physical actions while they practiced, but have learned through prior training on their primary instrument to convey their thinking in terms of auditory outcomes.

Almost certainly, many of the students in this class were describing their own thinking in ways that reflected the priorities of their course instructors who made such IF-EF relationships explicit during the period of face-to-face instruction in the first eight weeks of the spring semester (prior to the onset of online instruction). As extant research makes clear, teachers frequently focus inexperienced learner's attention on internal elements of performance (Cavitt, 2003; Colprit, 2000; Colprit, 2003; Worthy & Thompson, 2009), and even artist-level teachers are known to focus highly experienced musicians' attention on internal components of performance, but do so primarily in the service of external goals (Duke & Simmons, 2006). The fact that the less-experienced students in this study (e.g., WW and NW groups) reported thinking of IF and EF components in a balanced manner and often paired their actions with the sounds they created may illustrate how quickly knowledge of action-outcome relationships can be accessed by learners. This point also emphasizes how important it is for teachers to offer directives and feedback that make these paired associations clear.

Perhaps the greatest potential for future research lies in the exploration of interactions between learners' FOA, performance outcomes, and their perceptions regarding the learning process they are engaged in while practicing alone. The manner in which learners self-assess during active practice is a critical component of optimizing self-regulated cognition and behavior; specifically, highly self-regulated practicers assess their performance relative to their own best playing rather than an extrinsic reference point, such as the performance quality of another musician (McPherson & Zimmerman, 2002; McPherson, Osborne, Evans, & Miksza, 2017). In this study, note that the prompt that preceded the Self-assessment Scale asked students to assess their performance relative to "their own best playing." Nonetheless, some students, such as Glenn, might have selected a self-assessment rating that was instead reflective of some other self-imposed measure (e.g., their best playing on their primary instrument).

As will be discussed in greater detail in the next chapter (see Chapter 5, the OPTIMAL theory), students working independently likely benefit from the autonomy and sense of agency that emerges from the freedom to choose how they think or attend to their performance. Wulf and Lewthwaite (2016) assert that when learners take an active role in deciding how practice will proceed (autonomy) and feel that performance outcomes were the result of their own actions and thinking (agency), both performance and learning outcomes are optimized, especially when learners choose to focus their attention on task goals (EF) rather than some aspect of the body (IF). In the context of the Think Aloud project reported here, it is important to note that the students did not have autonomy over what they *did*, but rather what they *thought about* as they were doing it.

The verbalization patterns of the High-performing group certainly provide some evidence for Wulf and Lewthwaite's OPTIMAL proposal in that those students reported predominantly externally-focused thoughts (particularly for the Brass Primary Instrument group) and assigned high self-assessment ratings to their performances in each TA assignment. Students in the Low-performing group, by contrast, often chose to focus equally on EF and IF components. By TA3, students in the Low-performing group had improved and persevered, and their self-assessment ratings rose to a level comparable to those of the students in the High-performing group. This suggests that the LP group's balanced approach was, in fact, appropriate for their level of experience and fostered the development of action-outcome pairings. Of course, it is also possible that the changes we observed in Self-assessment Scale ratings over time could also be explained by regression to the mean.

There are limitations imposed by this study's design that constrain the interpretation of our findings. For example, we did not observe substantial shifts in the WW and NW students' FOA (as measured in this procedure) as their skills improved over the six-week span of the TA project. This should be taken into account in future research investigating the relationship between the effects of FOA on performance and the development of automaticity. Observations should be conducted over much longer durations, or include a wider cross-section of learner experience levels. Six weeks of practice may not be enough time to allow control of enough physical components involved in brass performance to become truly automatic. These or similar adjustments might reveal time- and automaticity-based changes in the way learners focus their attention.

Given that our study was conducted using a sample that was convenient, Primary Instrument and Performance Achievement groups were small and unequal, resulting in considerable variability within the smaller groups (Brass group, n=3, WW group, n=5) in particular. Clearly, conducting a similar study with more controlled group sizes would be beneficial and potentially allow for more sophisticated statistical analyses of differences between groups.

Though the Think Aloud protocol itself is a relatively time-tested approach used in explorations of performers' thinking in music and other domains (Bergee, 2005; Colley, Banton, Down & Pither, 1992; Ericsson, 2003; Lane, 2006; Norgaard, 2011; Pellegrino, 2014; Woody, 2006), it provides insight only into what students *reported* thinking about, not what they *actually* thought about—students' verbal reports could differ dramatically from their thoughts. As we posit earlier in this section, the students' reports could have been based on the most salient feature of their performance (e.g., poor intonation) and some conjecture about a likely cause, not necessarily what they actually remembered thinking about while they were playing. Additionally, authors in prior studies have reported that participants are prone to forget or ignore similar think-aloud instructions as they engage in the activity in question. This was almost certainly the case on occasion with the students in this study. There were also several instances where students struggled to remember what they had been thinking about on the previous trial and simply reported thinking about something plausible.

These limitations notwithstanding, our findings raise many questions about the role of FOA in self-directed learning, particularly in the early stages of studying a music instrument. We discuss these issues along with implications for future research and the practice of teaching in the final chapter of this dissertation.

Chapter 5: General Discussion

As Logan (2018, p. 1) so aptly put it, “Experts outperform novices but think less about what they do.” Perhaps more to the point, experts think *differently* than novices, focusing their attention on higher-order, task-related goals, an advantage afforded to them by the automatic processes that control the physical aspects of their performance (Logan, 1985, 1988; Schneider & Shiffrin, 1977; Shiffrin & Schneider, 1977) developed over countless hours of deliberate practice (Ericsson et al., 1993). Over the last 20 years, researchers have explored this idea more systematically, and their investigations have repeatedly demonstrated that an external focus of attention (FOA) promotes the recruitment of automatic motor control processes leading to performance enhancements, whereas an internal focus on the movements of the body during performance interferes with automaticity and results in performance decrements (see the *constrained action hypothesis,* Wulf et al., 2001; see Wulf, 2013, for a review).

When one considers the nature of teaching beginning or inexperienced instrumentalists, these findings may seem paradoxical. It seems logical to assume that learners in the initial stages of skill acquisition must focus their attention primarily on their body, and instrumental music teachers seem to structure learning experiences with this assumption in mind (Cavitt, 2003; Colprit, 2000, 2003; Worthy & Thompson, 2009). As musicians themselves, however, teachers know that skillful music performance is characterized by effort toward expressive rather than physical goals. Likewise, experienced musicians learning a new or less familiar instrument might adopt a similar approach, shifting their thinking advantageously between both internal and external elements of performance to achieve the desired musical results. In this dissertation, I reported the findings of three studies that explored these possibilities.

In the context of beginning band classrooms, teachers' verbalizations during instruction focused on a blend of internal and external components, with an emphasis on physical elements such as embouchure and breathing (see Chapters 2 & 3). Similarly, undergraduate music education majors' general perceptions of their FOA and the verbalizations they made during active practice on an unfamiliar brass instrument were well-balanced between IF and EF components. However, it was likely that for the few undergraduates whose primary instrument was in the brass family, their prior training with brass tone production would lead them to adopt an externally-focused approach; they did, in fact, report focusing predominantly on external elements of performance during active practice (see Chapter 4).

One of the overarching goals of our research was to determine if we could identify when and how a novice learner's thinking should shift away from the body. Interestingly, we observed no such time-related shift toward a predominantly external focus—not in the teachers we observed, nor in the students who were directing their own learning; however, we did observe both teacher and student verbalizations that *paired* various internal components with their effects on sound, evidence for what Wulf and Lewthwaite (2016) term *goal-action coupling*. Both teachers in beginning band classrooms and students practicing independently prioritized similar IF and EF components, like embouchure (IF) and tone (EF), structuring activities that promoted the exploration of paired relationships between the two components.

This pairing of internal and external elements is perhaps the most advantageous function of the blended IF-EF approach adopted by both the beginning band teachers and less experienced undergraduates. Without explicit knowledge of how various physical elements differentially affect sound, inexperienced students require guidance when resolving the performance problems they identify—this is where skillful teachers intervene. Interestingly, the less-experienced undergraduates practicing secondary brass instruments in the absence of their instructor's guidance seem to have recruited their own limited knowledge of paired relationships to address their performance problems. Recall that these students received face-to-face brass methods instruction for eight weeks in the first half of the semester; during that time, course instructors made frequent verbalizations that paired the internal and external components of performance. Although inexperienced with brass playing, music majors are accustomed to monitoring sounds they produce (EF) as a result of their extensive training on their primary voice or instrument, and likely transfer their monitoring behaviors to the context of learning an unfamiliar brass instrument, frequently utilizing the auditory information they acquire to deduce which physical elements (IF) they should change in order to improve the next trial.

If adopting an internal focus is beneficial to early experiences learning a wind instrument, when and how should a learner's focus become more external? Based on my interpretation of the findings presented in these three studies, I suggest that deepening our understanding of automaticity may be the answer. Music performance, like many other complex skills, requires the coordination of myriad discrete components and, because different components of a given skill automatize at different rates (Logan, 1985), attentional shifts between internal and external components are likely ongoing and might be more closely linked to variables such as instrument-specific or related experience, task familiarity, and technical demand. Thus, the "shift" I have referenced is perhaps better characterized as a situational choice that recurs as learners continually refine their skills and achieve more complex goals while the control of skill components gradually becomes increasingly automatic. Skilled teachers identify aspects of student performance (e.g., a sub-optimal embouchure) that will not support the achievement of more advanced goals in the short- and long-term. In these scenarios, it seems likely that teachers deliberately focus the learner's attention internally until the desired physical motions are achieved and automatized.

It is important to note, however, that the performance benefits of an external FOA have been observed even when participants declare a preference for an internal focus (Marchant, Clough, Crawshaw, & Levy, 2009; Weiss, Reber, & Owen, 2008; Wulf, Shea, & Park, 2001). In such a case, it could be that teachers facilitate the shift from an internal to an external focus periodically based on students' current level of skill and the goal at hand. As we reported in Chapter 3, Beth regularly incorporated playable melodies that presented relatively few technical challenges to students and afforded numerous opportunities to direct students' attention to the musical effects they wished to convey to an audience, simultaneously stimulating discussion among members of the class and critical thinking. Such strategies might serve as a gateway through which students can explore goal-directed thoughts and actions that characterize the critical elements of advanced musicianship.

THE *OPTIMAL* THEORY AND IMPLICATIONS FOR TEACHING AND LEARNING

Building on the established benefits of an external FOA and incorporating other cognitive and affective processes that occur during ongoing motor learning, Wulf & Lewthwaite (2016) proposed the OPTIMAL (Optimizing Performance Through Intrinsic Motivation and Attention for Learning) theory. The novel assertion of the OPTIMAL theory is that both attentional and motivational factors contribute to the coupling (pairing) of actions and task goals, enhancing performance and learning outcomes. The theory also proposes that, as learners choose to concentrate on task goals (EF) rather than focusing on the self (IF), subsequent improvements in their performance lead to positive affective responses that then serve to reinforce the self-directed decision to focus externally prior to performance and enhance learner expectancies of future performance outcomes. Wulf and Lewthwaite further propose that by offering learners choices about external goals on which to focus their attention, learners develop a sense that the performance enhancements they experience were indeed the result of both their choices and their actions (i.e., agency), strengthening goal-action couplings. Conversely, focus on the self (IF) rather than task goals creates feelings of incompetence and uncertainty as to the linkage between actions and outcomes (negative affect), lessening a learner's sense of agency and motivation to continue.

Within the framework of the OPTIMAL theory, a thoughtful teacher guides students toward external performance components that are most likely to enhance performance while fostering learner independence, autonomy, and enhanced expectancies. On its surface, this could present significant challenges to teachers as they regularly focus students' attention internally to ensure that fundamental, physical skills are maintained in increasingly sophisticated contexts. However, we suggest that teachers augment a goal-directed (EF) approach by strategically and explicitly targeting internal components to promote pairing. Teachers should provide students with individualized feedback and directives, both internally- and externally-focused, throughout instruction, beginning with the very first sounds made each day. Routine warm-up activities and drills, for example, offer teachers numerous opportunities to explicitly describe internal-external relationships as the students prepare their bodies and instruments to play beautifully.

In the context of both group instruction and self-directed practice, focused attention to internal components appeared to play a vital role in learning and skill development. It is important to be clear, however, that the manner in which teachers and students focus their attention on performance is not a dichotomous, "all-or-nothing" proposition. In general, our observations suggest that a mixed internal-external instructional approach in the beginning stages of music learning is beneficial, and that focused attention on internal components does not necessarily mean that teachers and students are ignoring critical external elements of performance. Students are most likely aware of the sounds they produce to differing degrees even as they think about the movements of their embouchure, for example. In this way, students learn to manipulate internal variables while simultaneously observing their effects on sound. Thus, just as Duke and Simmons (2006) reported in their observations of renowned artist-teachers, attention to physical components serves the external or expressive goal at hand.

Even highly skilled performers turn their thoughts back to internal components from time to time (Chaffin, 2007; Chaffin & Imreh, 1997, 2002; Chaffin, Imreh, Lemieux, & Chen, 2003; Chaffin, Lisboa, Logan, & Begosh, 2009; Chaffin & Logan, 2006). Periodically and strategically adopting an internal focus could serve as a means of expanding optimal performance when the achievement of external goals is constrained by the limits of automatized motor behavior. That is, if automatized movements fail to yield desired outcomes in a particular context, physical movements must be modified in some way. Recall that Glenn, who focused on predominantly external components during self-directed practice, may have been better served by focusing on internal components that were preventing him from performing the melody at a level he deemed satisfactory. Thus, adopting an internal focus temporarily could be advantageous when technical problems that prevent the expansion of skill are identified.

Attentional focus is but one component of the OPTIMAL theory. In terms of enhancing instruction, factors related to students' sense of autonomy and agency may play a more significant role during the learning process. Conventional approaches to instruction are most often teacher-directed, affording students few opportunities to choose a course of thought or action. Without support for learner choice, such an approach could result in negative affective responses and suboptimal performance outcomes leading to a loss of interest, low self-efficacy, and an increase in task avoidance (McPherson & Zimmerman, 2002; Wulf & Lewthwaite, 2016). As a solution, teachers should create opportunities for students to make their own choices, both in the classroom and the practice room.

Our observations provide some insight into the potential benefits involved in such an approach. Particularly, we observed students working independently in the Think Aloud project (Chapter 4) in which they were given complete autonomy; that is, students were assigned prescribed performance activities with certain constraints (e.g., a total of 10 repetitions of the assigned melody), but were free to decide *how* to proceed, attending to whatever they wished. While this freedom may have been inherently rewarding to some students, the lack of guidance may have induced stress in others. Still, it is possible that any success the students experienced as a result of making their own choices may have enhanced feelings of autonomy and agency.

When students were less successful in focusing their attention advantageously during self-directed practice, whether they were overwhelmed by the complexity and novelty of the task at hand or attending to their performance in a habitual manner, additional guidance or structure might have been helpful to them. Teachers should carefully consider both the positive and negative outcomes associated with increasing learner autonomy and ensure that opportunities for self-directed learning are sufficiently guided by clearly articulated goals and problem-solving strategies. Recall that Melissa asked students to reference checklists of internal components as a means of troubleshooting performance problems (see Chapter 2); the achievement of externally-focused goals requires that students develop problem solving, planning, and auditory discrimination skills. Teachers should provide students with models and ideal auditory images in conjunction with explicit descriptions of relevant physical components to guide their thinking as they play. Such an approach should also include frequent opportunities to perform easily playable repertoire that allows students to focus primarily on external goals and to make their own choices, just as accomplished musicians do. However, as discussed in Chapter 4, a student's choice of where to focus their attention is unlikely to change spontaneously without some type of intervention, particularly when they believe their own choices yield optimal results. In the absence of adequate structure or guidance, students could persistently focus on internal or external performance components disadvantageously, unwittingly ignoring more effective options.

While students' need for autonomy should be taken into consideration, the ultimate goal of both teaching and practicing is the improvement and optimization of performance outcomes. Our findings suggest that both an internal and external focus of attention provide a path to success, whether in the context of teacher- or self-directed learning. Teachers should design learning experiences that provide adequate structure based on individual student needs and promote the successful accomplishment of clearly articulated musical goals.

FUTURE DIRECTIONS

There are many aspects of the interaction between focus of attention and music learning and performance that have yet to be explored. The investigations reported in this dissertation were centered on the role of attentional focus in instructional contexts wherein learners engage in the process of skill acquisition and refinement. In an isolated performance context (i.e., a recital), when optimizing one's movements to create desired effects *in the moment* is the only goal, an external focus is clearly the superior choice. But how does a performer expand their capabilities without directing attention toward the internal elements that need to change?

According to the constrained action hypothesis, adopting an external focus promotes the recruitment of automatic motor control processes. Little is known, however, about the organization of such processes and the development of automaticity in the domain of music. Logan and Crump's (2011) proposed theory of hierarchical control in skilled typing (see Chapter 1) could provide a foundation on which to build similar theories and models describing the organization of automatic control processes in the context of music performance. Furthermore, experimental protocols designed to test such models could offer insight into the development of automaticity across various age and skill levels.

The extent to which environmental variables mediate the relationship between FOA and learning and performance outcomes remains an open question. Because our observations took place in naturalistic settings, it is not clear whether learners actually attended to discrete components of performance the way teachers intended, and we could not gather data describing concurrent changes in student performance relative to the students' FOA during ongoing instruction. The development of observation techniques that capture FOA and performance data unobtrusively during ongoing instruction and self-directed practice could be extremely useful when studying the effects of a learner's FOA on performance outcomes in a variety of contexts.

Applying Wulf and Lewthwaite's (2016) OPTIMAL theory to the practice of music teaching presents interesting challenges to researchers and educators alike. When teachers direct students' attention to internal components, does this lead to negative student affective responses and diminished learner autonomy as Wulf and Lewthwaite suggest? And when learners choose how to focus their attention as they practice, how do their choices and subsequent performance outcomes interact to promote autonomy? Future research accounting for these factors could further elucidate our understanding of the impact of attentional focus in the contexts of active practice and ongoing instruction.

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