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The use of pitch imagery in the management of trumpet embouchure: A theoretical consideration

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THE USE OF PITCH IMAGERY IN THE MANAGEMENT OF TRUMPET EMBOUCHURE: A THEORETICAL CONSIDERATION

by

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The purpose of this paper was to consider theoretically the use of pitch imagery in the management of trumpet embouchure. At issue was the pedagogical recommendation that a trumpeter should know the pitch of a note before playing it and then rely on that pitch image to manage automatically the physical operation of the embouchure.

A review of current psychomotor theory and related research lent validity to the recommendation. Pitch imagery could be characterized as pre-cuing or preprogramming information used in the setting of prestructured commands operating a motor program in an automatic, open-loop fashion described within motor schema theory. The fine-tuning of skill by feedback evaluation and error correction during performance was suggested to be automatic and unconscious in nature. Hence, conscious attention during performance may remain on pitch imagery rather than evaluation of embouchure activity.

A review of contemporary pedagogical opinion on embouchure revealed only occasional partial endorsements of the recommendation at issue. The recommendation was therefore characterized as outside the mainstream of pedagogical opinion. No consideration of the recommendation was found by the author in a review of research studies related to embouchure. Such research was found to be dominated by the examination of the physical characteristics of expert players, these characteristics often then used as a basis for formulating instructional strategies for less-skilled players. The approach of equating description of expert

characteristics with teaching prescription was challenged on the following points: 1) no research was found suggesting such a strategy would be effective, while research was found suggesting it is ineffective; 2) research efforts have failed to identify a single superior mode of expert embouchure function that could then serve as an instructional point of departure for such a strategy; and 3) expert characteristics may be symptomatic rather than causal in nature. Finally, lack of research consideration of the recommendation at issue was suggested to be in part attributable to behaviorist research standards dominating psychological inquiry from 1920 to 1970 that dismissed mental imagery as too introspective or mentalistic to be a legitimate subject of investigation.

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CHAPTER ONE

INTRODUCTION

Pitch imagery is a component of the auditory imagery representing a general musical performance goal. In contrast, pitch perception is a component in the evaluation of music heard. Gordon (1985, 34) describes a similar distinction in his use of the term audiation as meaning "the hearing of music in one's mind when the sound is not physically present. . . . In contrast, aural perception takes place when one hears music when the sound is physically present."

Pitch imagery is an aspect of audiation as defined by Gordon. However, pitch imagery can also exist while the sound of the pitch is physically present. This relates to the psychological orientation of the player during performance; that is, whether the player's conscious attention is directed toward a desired musical goal or toward evaluation of his performance effort. Though both can occur during the sounding of a pitch, the first orientation is before-the-fact in character and employs imagery, while the second is after-the-fact in character and employs perception.

The purpose of this paper is to consider theoretically the use of pitch imagery in the management of trumpet embouchure. At issue is a specific pedagogical recommendation to be derived from comments by trumpet pedagogues Robert Weast and Keith Johnson. Weast (1979, 8) comments as follows:

> The musical thoughts and intentions of the mind can cause all physical playing parts, especially the vibrating lip, to activate and respond automatically. . . . The primary signal or stimulus, to activate the playing system is pitch. The player must mentally hear each pitch he intends to play.

Johnson (1981,62) offers the following statements:

> Most changes and functions of the embouchure are so small and so refined that conscious attempts to control movement will probably be overdone, especially in the upper register where even small amounts of adjustment can result in considerable changes of pitch. A player will impart better directions to his embouchure by concentrating on the desired pitches than by attempting to think directly of the musculature involved. In addition, he will have a better chance of avoiding the destructive paranoia that so often accompanies inordinate and unwarranted attention to the embouchure.

The pedagogical recommendation derived from these comments is that a trumpeter should know the pitch of a note before playing it and then rely on that pitch image to manage automatically the physical operation of the embouchure. Chapter 2 will discuss the validity of this recommendation in light of current psychomotor theory and related research. Chapter 3 will discuss the recommendation's standing in contemporary embouchure pedagogy. Chapter 4 will offer a summary and discussion of teaching implications.

The range of this study is limited to consideration of the relationship between pitch imagery and trumpet embouchure. The assumption is made that pitch imagery is that component of auditory imagery most fundamentally related to embouchure management. This is not to say that other musical goals (such as a desired timbre, vibrato, volume, or style of articulation) may not also affect embouchure. However, as a means of limiting the range of discussion and of focusing attention on the merit of the pedagogical recommendation earlier stated, the broader issue of the relationship between multi-faceted auditory imagery and management of the entire physical playing process will not be discussed. Inferences concerning that broader issue are left to be drawn by the reader.

CHAPTER 2

PSYCHOMOTOR THEORY

Psychomotor theory here discussed is not offered as proven fact, but rather as informed opinion supported by current empirical research. For example, LaBerge (1981, 183) comments that his psychomotor theory of musical performance is an attempt to account for complex motor behavior, and as such is very difficult to examine by traditional experimental procedures. His views have therefore neither been strongly supported nor challenged by empirical evidence. LaBerge (p. 186) states,

> The reader should keep in mind that these remarks are based on reasoned inferences from theory, on some data from physiology, and from experiments on perceptual skills, such as reading. It is hoped that the field will not have to wait too long before these conjectures are tested by appropriate experiments.

LaBerge (p. 179) remarks that factual answers concerning how music performance skills are processed and how such skills should be taught are not yet at hand, but "houses were built before principles of design were clearly understood, and musicians have been trained regardless of our ignorance of the principles underlying performance skills." He concludes (p. 180), "Obviously, we cannot wait for basic research to provide final answers before training students."

The following discussion suggests an alternative to a common trend in brass pedagogy generally and trumpet embouchure pedagogy specifically.

That trend is to observe the physical details of expert performance and then equate such description with teaching prescription. Though the theories described here have admittedly not been proven (or disproven), the reader should also consider music skills researcher Steven Hedden's (1981, 25) question,

> Is there research-based evidence that suggests that students can acquire complex psychomotor (musical) skills more efficiently when they are provided with objective information that describes the requisite muscular activity?

Hedden (1981; 1987) has been unable to cite such evidence.

Closed- and open-loop theories

Two theoretical positions have dominated discussion of how a highly practiced movement is controlled (Summers, 1989, 49-50). Closed-loop theory emphasizes ongoing feedback evaluation during the movement. An error is identified by comparison of the actual movement with memory of the movement, such memory termed the perceptual trace. Any perceived error then stimulates corrections as the movement unfolds. Open-loop theory is founded on the notion of a neuromotor program being acquired through practice. This motor program contains all the information necessary for a movement to be carried out. A goal serves to activate the program, and the entire movement is then performed without reference to feedback. Therefore, open-loop theory proposes that a movement can be structured prior to rather than during performance.

Early empirical evidence for motor programs is found in a medical case study by Lashley (1917) involving a patient who had suffered a gunshot wound to the spinal cord. Despite being deprived of limb movement sensations (or kinesthetic feedback), the patient was capable of reproducing limb motion. Lashley proposed such movement must be centrally controlled by a motor program as no peripheral feedback was available to guide the movement in a closed-loop fashion. Animal studies have since provided further evidence that limb movement is possible in the absence of kinesthetic feedback (for a review of sources see Summers, 1989, 51).

A music study concerning primary feedback deprivation was conducted by Ward and Burns (1978). The researchers hypothesized that auditory feedback could not be a factor in the singing of a very short note, as the auditory feedback circuit would not have had a chance to operate before the note ended (p. 24). Embracing a closed-loop, feedback-dependent perspective, Ward and Burns suggested kinesthetic feedback (or "feel" for muscle positioning) must be responsible for producing the desired intonation in the performance of such a note. To test singing skill in a condition assuring absence of auditory feedback, the researchers used a masking signal to deprive four trained and four amateur singers of such feedback during the performance of a series of simple vocal tasks. In the absence of auditory feedback, pitch accuracy (especially of the trained singers) was characterized as good, and cited as proof of effectiveness of kinesthetic feedback (p. 43). However, no means of measuring the actual influence of kinesthetic feedback was devised, hence the influence of such feedback was simply presumed by the researchers. Since the singer's imagery of pitch (or knowledge of the target pitches involved) was a stated precondition of the experiment (p. 24), a plausible interpretation of results would be that a motor program activated by a goal represented by pitch imagery was responsible for the accuracy witnessed in pitch production in the absence of auditory feedback. Ward and Burns do not cite the possibility of this open-loop, feedback-independent interpretation of their results.

Although the results of Lashley's (1917) medical case study, animal studies cited by Summers (1989, 51), and the singing study of Ward and Burns (1978) suggest that motor programs exist, the skill of subjects deprived of primary feedback during movement is characteristically somewhat clumsy, with reduced control and precision evident. Summers (1989, 51) concludes that feedback "seems necessary to perfect the fine detail of movement, and to monitor the overall accuracy of the motor program."

Schema theory

A schema theory of discrete motor skill learning is proposed by Schmidt (1975). He defines a schema as a set of abstracted rules serving as instructions for producing a conceptual goal (p. 233), with discrete tasks defined as those short in duration and having a recognizable beginning and end (p. 230). Schmidt (pp. 230-231) cites as important points of departure Adam's (1971) closed-loop theory, Bartlett's (1932) notion of the schema, Pew's (1974) suggested application of the schema to motor learning, and Lashley's (1917) notion of motor programs. Thus, Schmidt's theory can be viewed as a combination and refinement of both closed- and open-loop viewpoints.

Schmidt (1975, 237) details two primary schemata involved in the performance of discrete tasks. A recall schema generates a best estimate as to how to achieve the desired outcome. A recognition schema generates a best estimate of the expected sensory consequences of a correct movement, which is then compared to the sensory consequences of the actual movement.

Schmidt's theory represents an advance over past motor theories in that both rapid movements and novel movements (involving flexibility or adaptability of response) are accounted for. The existence of novel movements is particularly seen as supporting the schema notion. For example, an individual's characteristic handwriting style is apparent even when a person produces novel movement in trying to write with the nondominant hand, or with a pen taped to the foot or held in the mouth (Raibert, 1977, as cited by Summers, 1989, 59). This supports Schmidt's (1975, 232) view that a generalized motor program or schema exists that guides a class of movement in efforts to achieve a conceptual goal.

The issue of movement novelty was central to Bartlett's (1932) original schema hypothesis. He observed that in making a tennis stroke, a player is never exactly repeating any stroke made previously (p. 202). Such flexibility or adaptability of motor response was observed in an electromyographic study of brass embouchure (Isley, 1972; Isley and Basmajian, 1973). Subjects were seven trumpet players and one trombonist, all advanced players. Fine-wire intramuscular electrodes were used to evaluate electrical activity in ten facial muscles during performance. Isley and Basmajian (1973, 143) observed, "The production of specific notes at specific volume on trumpet and trombone do not depend on exact patterns of activity in the muscles of the lips and buccinator (cheek)." Isley (1972, 173) commented, "The data obtained in this study show wide inter-subject and intra-subject variation and suggest that an individual may perform in many different ways tasks involving facial muscles." The conclusion was drawn that no one mode of embouchure performance could be identified as physically superior to another (Isley, 1972, 170; Isley and Basmajian, 1973, 145).

LaBerge (1981, 184-186) examines schema theory in relation to musical performance. Citing studies that indicate the connection between voluntary commands and muscle movements is quite remote physiologically, he distinguishes between higher global or executive structures within the voluntary control centers deep in the brain (basal ganglia and cerebellum), and lower cortical coordinative structures operating close to the muscular systems. Commands from the executive level need only select the type and mode of movement desired. The coordinative structures then translate this global information automatically into finely tuned muscle actions. LaBerge characterizes the motor schema as a global, higher level structure that does not communicate directly to individual muscles. Instead, coordinative structures exercise direct control over muscle activity. In a study of piano performance, Shaffer (1981, 331) concurs and cites studies in movement dynamics that indicate a motor command specifies a movement goal rather than details of muscle contractions.

Within LaBerge's view, pitch imagery could be characterized as global information specifying a particular mode of movement. The embouchure musculature would then be managed automatically by appropriate coordinating structures in the effort to produce the desired pitch.

Schmidt's perspective suggests a similar description. Schmidt (1975, 233) views freedom from feedback involvement as the aim of motor skill learning. Such freedom depends on a well-developed motor program that can be operated in open-loop fashion. Such operation relies on prestructured commands, which in turn rely on what Schmidt terms "response specifications" (p. 232). Summers (1989, 56) and Shaffer (1981, 327) use the term "pre-cuing," while Holding's (1989, 283) term is "preprogramming." All refer to the need prior to movement of specific goal information, such as pitch imagery in the case of trumpet performance.

Automaticity

The motor schema framework of Schmidt (1975) offers a theoretical explanation for automaticity. Bloom (1986) summarizes automaticity research from 1899 to the present, and defines the phenomenon as action without conscious attention which is characterized by economy of effort, rapidity, high accuracy, and the freedom to direct conscious thought elsewhere (p. 74). LaBerge (1981, 181) views automaticity as a requirement of advanced musical skills. Winstein and Schmidt (1989, 32) cite studies (Denier van der Gon and Wieneke, 1969; Schneider and Fisk,

1983) that observed automaticity in the movement of highly skilled artists, musicians, and painters. These studies point to automaticity as allowing one's attention to be directed toward emotional expression.

Views on automaticity in brass pedagogy are wide-ranging. Fox (1974, 89) comments, "There are physical disciplines that have to be learned, they are artificial impositions. . . . Do they become automatic? No!" In contrast, Maurice Andre's response to Weast's (1979, 5) question of how playing is controlled was, "C'est automatique." In sympathy with Andre are comments on trumpet embouchure by Harry Glantz and Adolph Herseth. When asked to describe details of embouchure control, Glantz (Faulkner, 1961, 100) replied, "I just screw up my lips and blow!" Herseth (Neidig, 1977, 43) responded to questions about embouchure specifics with the following comment: ". . . the minute I start thinking about that I can't play, so I don't think about it."

Automaticity is revealed in actions during playing of which the player is unaware. In reference to his discussion of Reinhardt's (1964) pivot embouchure system, Smith (1967, 95) comments, "One renowned trumpet virtuoso was questioned recently about the pivot in one of his clinics. He admitted to having one, but only after someone pointed it out to him did he even realize its presence."

The presence of automaticity in trumpet playing is also revealed in the extreme circumstance of discrepancies reported between what players believe they do while they play compared to what they are actually observed doing. Such discrepancies were noted by Haynie (1969, as cited by Hedden, 1981, 25) in his X-ray and videofluorographic studies of oral cavity adjustments during trumpet performance. Johnson (1981, 62) offers a similar observation with the following anecdote:

> Several years ago I attended a clinic presented by a well-known trumpet player who spoke at length about the need to use a dry embouchure to prevent the mouthpiece from slipping and to "lock" the embouchure into place, especially in the upper register. He went to considerable trouble to dry his mouthpiece and lips before playing. However, sitting only a few feet from him during the clinic, I was able to see that just before he started to play each time, the tip of his tongue quickly touched his lips, replacing at least some of the moisture he had so carefully tried to eliminate.

Andre's (Weast, 1979, 5) comment that trumpet playing is automatic can be confusing. It needs to be noted that automaticity does not exist in a void of information. Automaticity refers to automatic physical or muscular activity carried out to achieve a conceived goal, in the open-loop manner described within motor program theory. Physical action is dependent upon specific goal information that pre-cues or preprograms the motor program. In the automatic functioning of the embouchure, pitch imagery would be critical pre-cuing information.

Why has this point not been more often emphasized by those espousing automaticity in trumpet playing? Consider that automaticity is most often espoused by outstanding players. Such players may be expected to have unusually good pitch acuity. According to motor program theory, such acuity would act automatically in aiding playing. Therefore, such automaticity may result in pitch acuity being a personally unidentified factor in playing success. Also, Siegel (1981, 203) notes that many musicians having good relative pitch may view this ability as universal. It may therefore be taken for granted by the expert player that everyone has such ability. Hence, the issue of pitch imagery does not become a point of emphasis in the expert's teaching of the student.

Feedback and conscious attention

In the previous discussion of motor programs, the emphasis has been on open-loop operation of prestructured movement. That is, conscious attention is placed on a goal, the specifics of that goal trigger the automatic functioning of coordinating structures within the lower levels of the central nervous system, and such structures guide muscle activity to achieve the goal desired. However, motor programs are not thought to run purely in an open-loop fashion. If they did so, feedback during the movement would be irrelevant. Summers (1989, 51) notes that such feedback seems necessary to perfect or fine-tune movement. Limb movement without feedback is possible; thus, the existence of motor programs is supported. However, movement without feedback is somewhat clumsy, lacking a degree of precision and fine control.

Is this fine-tuning feedback evaluated and are corrections initiated during movement through conscious attention at higher levels of the central nervous system, or by automatic actions of coordinating structures at lower levels? This is a point of contention, as reflected by Holding's (1989, 281) comment that "feedback, whether or not it is consciously processed, is of central importance to the development and maintenance of complex skilled activities."

The issue is critical to speculations of how motor programs are developed and refined. Concerning specifically the use of pitch imagery in the management of trumpet embouchure, a critical question arises. Should conscious attention while playing be focused on evaluating embouchure feedback; that is, should attention be placed on feeling the amount of mouthpiece pressure used or sensing the degree of tension in the corners, for example? In this case, pitch imagery could be viewed as a valuable prerequisite to begin playing a particular pitch, but not necessarily the ongoing focus of attention in embouchure management. Or should conscious attention remain on what LaBerge (1981, 187) describes as global information (that is, one's conceptual goal), with automatic evaluation of feedback at lower levels of the central nervous system then relied upon? In this case, an auditory image of the pitch the player wants to produce would remain the focus of conscious attention during playing. Pitch imagery would be, in effect, relied upon to manage the embouchure, with no conscious thought then given to the physical specifics of embouchure while playing.

Playing is certainly possible with one's conscious attention focused on attempting to evaluate and manipulate the physical specifics of embouchure. Experiments in biofeedback (Basmajian, 1963) have demonstrated that man can consciously control isolated contractions of a single muscle unit. A study of clarinet performance by Basmajian and Newton (1974, 92) explored the possible use of biofeedback in controlling aspects of embouchure. Electromyographic (emg) monitoring revealed a characteristic pattern of muscle activity in the buccinator muscle of the cheek in expert clarinetists that was not matched by less-skilled players. Using artificial feedback in the form of viewed oscilloscope monitoring of emg activity, nine clarinetists were trained to suppress or recruit at will emg activity in the upper and lower buccinators while playing. The subjects easily acquired the skill to alter consciously the activity of a single muscle. Basmajian and Newton (p. 92) concluded that biofeedback "may offer a method for teachers to alter muscle responses during musical performance on wind instruments."

However, one finding reported was most significant, though its implications were not considered by Basmajian and Newton. When subjects consciously either suppressed or recruited activity in the buccinator while playing, no audible or recordable change of tone resulted (p. 92). Two inferences may be drawn that are particularly relevant. The first is that physical description of expert performance does not equate to teaching prescription. If conscious alteration of muscle activity does not change performance, then mimicry of expert emg characteristics is of no value to a less-skilled player. This agrees in principle with Edfeldt's (1960) interpretation of results in his emg evaluation of silent speech movement in good and poor readers. He found that good readers in fact do engage in less silent speech than poor readers (p. 153). After a detailed analysis of results, however, he concluded that silent speech was simply symptomatic of poor reading skill, was not of itself detrimental to a poor reader's performance, and should not be discouraged in an effort to match the characteristic of good readers as had been commonly prescribed (p. 154). In other words, Edfeldt viewed the expert characteristic as symptomatic rather than causal in nature. Similarly, an analogy might be suggested employing Jean Piaget's cognitive development theory; specifically, his view of knowledge acquisition in young children. Piaget (Bell-Gredler, 1986, 214-215) contends young children cannot simply be given finished products of adult (expert) knowledge, but rather must autonomously construct knowledge through a personal process of discovery. Understanding comes about as an individually unique, sequential process that cannot be circumvented by attempts to impose the thinking characteristics of the expert adult. The analogy in terms of psychomotor skills might be that the physical characteristics of experts are the end result of a personally unique process of skill development, and such characteristics cannot be imposed on less-skilled players in an effort to circumvent their own developmental process.

The second inference drawn from the result of the study by Basmajian and Newton (1974, 92) is that an automatic compensation must be readily occurring to maintain a desired (familiar) tone quality in the face of conscious intervention to alter a single muscle's activity. Such novel or flexible response is in sympathy with the notion that a general tone production motor program or schema exists and that appropriate coordinating structures are automatically evaluating muscle activity and facilitating changes that will maintain ongoing realization of the desired goal. This agrees with Bernshtein's (1967) contention that lower coordinational systems automatically evaluate ongoing feedback and make appropriate adjustments during movement.

In regard to such automaticity, Winstein and Schmidt (1989, 20-26) discuss in physiological detail seven intrinsic sensory information (or kinesthetic feedback) sources that mediate error correction during movement by "relatively automatic, unconscious processes (p. 37)." These sources are 1) the muscle spindle, 2) the Golgi tendon organ, 3) articular receptors, 4) cutaneous receptors, 5) the vestibular apparatus, 6) vision, and 7) audition. The automatic, unconscious nature of error mediation involving these sources was deduced from empirical evidence reviewed by Winstein and Schmidt (pp. 26-37). Research has suggested that the shortest amount of time needed to initiate voluntary or conscious change in behavior is approximately 150 msec. In experiments designed to isolate feedback dependence on the intrinsic sources just listed, motor corrections of induced error were observed that were much more rapid than could be accounted for by conscious or voluntary processes.

These findings suggest that placing conscious attention on the physical specifics of embouchure while playing in order to evaluate feedback may be unnecessary or redundant. Also, there exists the possibility that conscious evaluation of embouchure may confound playing, especially if such evaluation is founded on a false premise deduced from observation. A recent study (Barbenel, Davies, and Kenny, 1986; Davies, Kenny, and Barbenel, 1987; Kenny, 1985) of mouthpiece pressure in trumpet performance reveals a case of such false deduction.

Davies, Kenny, and Barbenel (1987, 23) note the common belief among trumpeters that correct performance involves minimal mouthpiece pressure. The following three main hypotheses underlying this belief were tested: 1) expert players use minimal levels of force; 2) less expert players use more force (especially in the upper register) as means of compensating for improper technique; 3) the use of high levels of force results in signs of physical stress (absent from expert players) that indicate excessive force is being used. The performance of 60 trumpeters (comprising skilled and less-skilled groups) was evaluated using close-up photographs and measurements of mouthpiece force. Mouthpiece force was measured by a specially designed device, a brass tube which was inserted into the mouthpipe and then into which the mouthpiece was inserted (p. 24). The device was sensitive to minute variance in electrical resistance caused by stress changes.

Experimental results indicated skilled players do not use either absolute levels of force or a range of forces differentiating them from less-skilled players (p. 26). In comparing photographs of different players, observers rated obvious signs of stress as generally indicating use of greater mouthpiece pressure, though pressure readings often indicated that the opposite was true (p. 29). This prompted the researchers to comment that

> some of the professionals could use massive amounts of force while maintaining a madonna-like appearance, to the extent that we were moved to recalibrate our machinery to ensure it was still working properly (p. 29).

The common suggestion by teachers to struggling students that they should use less mouthpiece pressure appears, therefore, to be misguided. The critical issue would appear to be the appropriateness of the playing task in light of the student's current degree of embouchure muscle tone.

To summarize, the efficacy of placing conscious attention on the physical aspects of embouchure activity can be challenged in several ways. As just discussed in the review of the study on mouthpiece pressure by Davies, Kenny, and Barbenel (1987), conscious attention may be misplaced due to confounded observation of the playing process. Basmajian and Newton's (1974) electromyographic study of clarinet embouchure demonstrated a novice's conscious control of a single muscle's activity within the embouchure in mimicry of an expert's activity was possible, but that such control did not alter playing results and thus was an ineffective strategy for improvement. Isley's (1972) electromyographic study of ten muscles in the trumpet embouchure was unable to demonstrate a mode of performance superior to another because there existed significant inter- and intra-subject variation in embouchure activity among expert players. Thus, no universal description of expert embouchure characteristics could be derived to serve as the basis for an instructional prescription that could then direct placement of conscious attention on appropriate muscle activity. An issue not previously discussed arises from consideration of Leno's (1970) high-speed photographic study of trombone embouchure. Leno (p. 73) confirmed that the vibration frequency of a trombonist's lips was the same as the pitch produced. If the same characteristic is assumed for trumpet performance, then the embouchure would be vibrating 440 times per second in producing the pitch a'. The assumption that a player can consciously differentiate aspects of so rapid and intricate a task would be questionable (Johnson, 1981, 62). Winstein and Schmidt's (1989, 26-37) review of research into error mediation in motor skill development cites the automatic, unconscious nature of such mediation. Hence, conscious evaluation of embouchure activity could be characterized as redundant or unnecessary. Finally, there is the recommendation of relying on physical automaticity in playing to allow greater attention to be placed on musical expression (Denier van der Gon and Wieneke, 1969; Schneider and Fisk, 1983).

Conclusion and summary

A review of current psychomotor theory and related research lends validity to the recommendation that a trumpeter should know the pitch of a note before playing it and then rely on that pitch image to manage automatically the physical operation of the embouchure. Pitch imagery might be characterized as a "response specification" (Schmidt, 1975, 232), or "pre-cuing" (Summers, 1989, 56; Shaffer, 1981, 327), or "preprogramming" (Holding, 1989, 283) in the setting of prestructured commands operating a motor program in an automatic, open-loop fashion described within schema theory (LaBerge, 1981; Schmidt, 1975). The fine-tuning of skill by feedback evaluation and error correction during performance is suggested by research (for review see Winstein and Schmidt, 1989, 26-37) to be automatic and unconscious in nature. Hence, conscious attention during performance may remain on pitch imagery rather than on evaluation of embouchure activity. Such reliance on

pitch imagery and abandonment of conscious consideration of the physical specifics of embouchure operation could be termed "letting go" in the manner described by sports psychologist
Charles Garfield (1984). Garfield (p. 184) comments that letting go means learning "to trust the complex subconscious mechanisms that ultimately determine peak performance."

CHAPTER 3

EMBOUCHURE PEDAGOGY

The following pedagogical recommendation has been supported by a review of current psychomotor theory and related research: a trumpeter should know the pitch of a note before playing it and then rely on that pitch image to manage automatically the physical operation of the embouchure. The issue of the ensuing discussion is this recommendation's standing in contemporary embouchure pedagogy.

The discussion reflects a review of recent pedagogical opinion on and research studies related to embouchure. The review included in part a comprehensive survey of Dissertation Abstracts International and the following journals: Brass Bulletin, The Brass World, Bulletin of the Council for Research in Music Education, The Instrumentalist, International Trumpet Guild Journal, and Journal of Research in Music Education. As a result of this review, the following sources of pedagogical opinion were selected for detailed consideration: Bellamah, 1976; Bobo, 1981a, 1981b; Bush, 1962; Caruso, 1979; Chapman, 1985; Dale, 1965; Davidson, 1970; Ellis, 1987; Farkas, 1962; Faulkner, 1961; Fox, 1974; Gordon, n.d.; Grocock, 1968; Hanson, 1968; Hickman, 1978; Johnson, 1983, 1981; Kelly, 1983; MacBeth, 1975; Mathez, 1987; Neidig, 1977; Nelson and Allexander, 1976; Noble, 1964; Reinhardt, 1964, 1942; Richtmeyer, 1966; Ridgeon, 1976; Ruettiger, 1976; Russo, 1973; Sauer, 1978; Saxton, 1971; Severson and McDunn, 1983; Sherman, 1979;

Smith, 1967; Stevens, 1971; Stewart, 1987; Weast, 1979, 1974, 1970, 1968, 1965; Young, 1977. The following research studies related to embouchure were considered in detail: Amstutz, 1977, 1970; Barbenel and others, 1986; Bouhuys, 1965, 1964; Briggs, 1968; Carter, 1966; Damste, 1966; Davies and others, 1987; Faulkner and Horvath, 1967a, 1967b; Faulkner and Sharpey-Schafer, 1965; Gibson, 1973; Hall, 1954; Henderson, 1942; Hiigel, 1967; Holdsworth, 1974; Isley, 1972; Isley and Basmajian, 1973; Kenny, 1985; Kenny and Davies, 1982; Leno, 1970; Malek, 1953; Martin, 1942; Meidt, 1967; Merriman and Meidt, 1968; Myers, 1979; Nichols and others, 1971; Olson, 1972; Porter, 1970, 1968; Testa, 1974, 1972; Weast, 1963, 1958; Weast and Hake, 1965; White, 1972; White and Basmajian, 1974, 1973. These sources are listed to afford the reader an overview of the brass pedagogical material considered in the formulation of the following discussion.

Pedagogical opinion

Views on embouchure vary widely in their degree of physiological detail and the amount of awareness of such detail considered necessary for a player to attain skilled performance. Stevens (1971, 8-11) suggests a nine-step procedure for establishing conscious awareness of embouchure function. In addition, the player is advised to memorize an anatomical chart of twelve embouchure muscles (p. 16), and know the cited embouchure function or directional action of each (pp. 17-23). At the other extreme is Herseth's (Neidig, 1977, 43) comment:

> There are some rules, of course - you wouldn't want 90 percent of the upper lip in there (the mouthpiece), or 90 percent of the lower lip. There should be some equitable distribution. But it's basically a matter of getting it where it sounds the best and works the most comfortably. From that point on you just forget it. Maurice Andre once said that he never saw a country where people worry so much about their chops as they do in America. He asks, "Why don't you just pick it up and play?" I couldn't agree more.

Herseth's comment can be viewed as sympathetic to the pedagogical recommendation at issue here, but his view is certainly not a specific endorsement. Similarly sympathetic and somewhat more specific is the following remark by Davidson (1970, 2) made during discussion of his opinion that the lips should be in a state of complete repose just prior to the attack:

> . . . at the moment of attack the note itself has set the tension of the lips at the absolute minimum tension required for that note - pre-setting the tension of the lips for a given note almost always results in excessive tension.

Davidson does not reiterate or pursue this point during his subsequent discussion of embouchure (pp. 4-5).

Another partial or tangential endorsement is found in a comment on tone production by William D. Revelli, as cited by Hanson (1975, 9): ". . . playing with a good tone quality is an auditory, physical and mental reaction which can never be mastered until the player can actually hear, see, and feel a tone before it is played." This comment is in line with Reinhardt's (1964) views, though his emphasis is ultimately on what he terms "sensation theory" in which "the player relies primarily on <u>feeling</u> rather than <u>sound</u> to produce his notes

(p. 13)." A conflict exists between views touting conscious feeling in setting the embouchure and the pedagogical recommendation here at issue which discounts the conscious awareness of such feeling, as in these comments by Jacobs (Bobo, 1981b, 45), "I don't care how the lip feels; I don't care how I feel. . . . my whole concentration is not on what I feel like or what I sound like, but what I want the audience to hear."

Porter (1970, 50) observes that wind teachers often advise pupils to "imagine you are singing when playing." This suggestion can be viewed as sympathetic to the idea that one should know the pitch of the note one wishes to produce before playing it, and then rely on that pitch image to manage automatically the physical operation of the embouchure. However, Porter (p. 50) does not relate this "singing" approach to embouchure management, but rather to the encouragement of supplementary resonation in the mouth, head, throat, and chest cavities. Similarly, Saxton (1971, 22-23) equates a singing approach to promoting vibration in the larynx sympathetic to the lip's vibration while playing. An advocate of the singing approach who avoided comment on any specific physiological impact of such an approach was trombonist Emory Remington (Sauer, 1978). Sauer (p. 38) states, "Remington's principal teaching device was to sing virtually every note in every lesson." Sauer (p. 39) continued, "Technical explanations were completely absent."

An approach more completely sympathetic to the recommendation at issue is the view that the use of the vocal cords in singing is analogous to the use of the lips in trumpet playing. Acoustician Arthur

Benade (1976, 391) offers the following comment:

> The orchestral brass instruments and the human speech system are acoustically similar: both have a flow-control device that admits air into an elongated air column whose open far end acts as a source that excites acoustic disturbances in the surrounding air. In both cases the performer controls the pitch of his tones by making adjustments to the tension and inertia of a pair of fleshy folds (either the singer's vocal cords or the brass player's lips).

Benade stops short of suggesting adjustments in tension and inertia are managed by use of pitch imagery in playing the trumpet as in singing. Jacobs (Russo, 1973, 30) goes further when suggesting brass players have to think their pitch (as a singer would) in order to "put the pitch into the instrument . . . ." Jacobs (Stewart, 1987, 142) comments:

> If you think of vocal cord activity, you'll find that the lips actually become the vocal cords of the brass instrument. . . . It (the brass instrument) does not have the ability to provide you with the pitch when you just blow, like in some of the woodwinds. So the brass instrument is close to singing, and I think the brass player should mentally consider himself close to the singer . . . .

Colwell (1969, 120) employs a similar analogy in stating, "By 'thinking' higher or lower pitches, the (brass) player can increase and decrease the speed (of the lips' vibration) in much the same way a singer produces higher or lower pitches."

To this point, pedagogical opinions sympathetic in varying degrees to the recommendation at issue have been cited. More thorough endorsements include comments noted in this paper's Introduction by Robert Weast and Keith Johnson. To reiterate, Weast (1979, 8) comments:

> The musical thoughts and intentions of the mind can cause all physical playing parts, especially the vibrating lip, to activate and respond automatically. . . . The primary signal, or stimulus, to activate the playing system is pitch. The player must hear each pitch he intends to play.

Johnson (1981, 62) suggests the following:

> Most changes and functions of the embouchure are so small and so refined that conscious attempts to control movement will probably be overdone, especially in the upper register where even small amounts of adjustment can result in considerable changes of pitch. A player will impart better directions to his embouchure by concentrating on the desired pitches than by attempting to think directly of the musculature involved. In addition, he will have a better chance of avoiding the destructive paranoia that so often accompanies inordinate and unwarranted attention to the embouchure.

The most thorough endorsement identified, however, is by hornist William Robinson (1987, 67) in describing his first lesson with Arnold Jacobs, though the passage presented offers broader implications than the recommendation in question:

> He (Jacobs) immediately recognized the fact that I had fallen into the trap of concentrating on the action of the embouchure, body muscles, and other technical actions connected with playing a wind instrument. Without warning, he tossed me a pencil, and without thinking, I caught it in mid-air. This simple act drove home to me a point that is probably one of the most important things I have ever learned in horn playing. He said, "You don't have to think which muscles in your arm and in your fingers you needed to use to catch the pencil. You instinctively wanted to catch the pencil and your brain, which is the greatest computer ever created, relayed the message to each muscle involved. If you want to play a particular tone, put that tone in your mind and in your ear - the exact pitch, the quality you want, the desired volume - then play the tone and the brain will tell the body what to do. This will happen, provided you open the mouth, take a breath, and blow an air column. Sing the pitch in your mind and in your ear, use the air and you are using two principles of playing that are fundamental to artistic playing: song and wind."

Endorsements, limited or otherwise, for the idea of knowing the pitch in advance and relying on that image to manage the embouchure automatically, are difficult to find. No instances of the recommendation being considered and then rejected were found. Rather, the recommendation apparently has simply not often been considered. Surveys conducted by Richtmeyer (1966) and Bellamah (1976) serve as examples. Richtmeyer (1966) sent 118 well-known brass teachers and performers a questionnaire to gather information concerning successful teaching approaches to embouchure. He received 66 responses. No mention was made in the questionnaire of any possible link between pitch imagery and embouchure management. Also, no such link was suggested by any respondent in the portions of the questionnaire that allowed suggestions outside the specific questions asked. Bellamah's (1976) survey involved questions on many aspects of brass playing, including specific questions concerning embouchure. Among his respondents, Bellamah (pp. 6-8) listed trumpeters Vincent Bach, Louis Davidson, Maynard Ferguson, John Haynie, James Neilson, Leonard B. Smith, Clark Terry, and Mike Vax. Again, no survey question suggested a link between pitch imagery and embouchure management, nor was such a link suggested by any respondent. As a final example, Isley (1972, 69-148) offers an extensive review of pedagogical opinion on a wide range of brass embouchure issues, citing 128 pre-1972 sources. No mention of a possible link between pitch imagery and embouchure management is made. The recommendation at issue might be characterized, therefore, as outside the mainstream of pedagogical opinion.

Research studies - expert characteristics

At issue is the recommendation that a trumpeter should know the pitch of a note before playing it and then rely on that pitch image to manage automatically the physical operation of the embouchure. No research studies related to trumpet or brass embouchure were found that considered such a recommendation.

Pedagogical research has been dominated by examination of the physical characteristics of expert players (Amstutz, 1977, 1970; Bouhuys, 1965, 1964; Carter, 1966; Faulkner and Horvath, 1967a, 1967b; Gibson, 1973; Hall, 1954; Hiigel, 1967; Isley, 1972; Isley and Basmajian, 1973; Leno, 1970; Malek, 1953; Meidt, 1967; Merriman and Meidt, 1968; Myers, 1979). At times these characteristics have been compared to those of less-skilled or novice players (Barbenel and others, 1986; Briggs, 1968; Davies and others, 1987; Faulkner and Sharpey-Shafer, 1965; Henderson, 1942; Kenny, 1985; Kenny and Davis, 1982; Weast, 1963; Weast and Hake, 1965; White, 1972; White and Basmajian, 1974, 1973).

The hope of such research has often been that the description of expert characteristics will offer a basis for formulating an instructional strategy for less-skilled players. Amstutz (1970, 2-3) comments within his study of oral adjustments during trumpet performance,

> Given precise knowledge of the role performed by the tongue, aperture, and pivot, an instructor would be able to recommend in a more intelligent and logical manner, thereby simplifying the difficulties experienced by younger trumpet performers.

Amstutz seeks to develop a pedagogy based on conscious consideration by the player of specific physical characteristics of the playing process, as reflected by his comment,

> While it has been established that the aperture, instrument pivot, and tongue arch definitely contribute to effective trumpet performance, I would like to note that when carried to extremes, these techniques can produce negative results. It is recommended that each technique be introduced separately and the student observed on a regular basis to prevent extreme response from becoming a habit (1977, 26).

Such an involvement by the player in the physical aspects of performance has been assumed desirable within the mainstream of brass pedagogy. Hence, identifying the physical characteristics of expert performance and attempting directly to apply those characteristics to the playing process of less-skilled players has been a dominant pedagogical focus. This approach has been challenged, however. Hedden (1981, 25) questioned that proof exists for such an approach in asking,

> Is there research-based evidence that suggests that students can acquire complex psychomotor (musical) skills more efficiently when they are provided with objective information that describes the requisite muscular activity?

In Hedden's (1981, 1987) surveys of music skills research, he was unable to cite such evidence.

Testa (1974, 1972) sought to examine the efficacy of jaw-thurst instruction for young trumpet players. His research study is the only one found that employs an experimental design attempting to determine the effectiveness of a specific embouchure teaching technique. He concluded, "Jaw-thrust instruction for young players appears to be superior to regular instruction as a means of improving intonation, ascending range, and lip flexibility (1974, 197)." However, Testa's study does not offer the evidence that Hedden sought, in that the phrase "regular instruction" in Testa's conclusion refers to another mode of direct physical intervention, the "smile-pucker" method (p. 189). The smile-pucker method is advocated by Farkas (1962, 10-15) as a means of combining two seemingly opposed but common pedagodical approaches to embouchure, the smiling embouchure and the puckered embouchure. Farkas (p. 15) recommends the development of a "sense of balance between the two opposing forces so that the lips are in a half-smiling, half-puckered condition." He characterized this balance as a tug-of-war (p. 13), though an electromyographic study of trumpet embouchure has since concluded no such pitting of muscles against muscles actually occurs (White and Basmajian, 1974, 299). In the case of Testa's (1974, 1972) study, jaw-thrust instruction is being compared to another method of direct physical intervention. Hedden's (1981, 25) question would possibly have been confronted only in the event Testa's control group had received no directly physically intervening embouchure instruction.

A prerequisite to using a description of expert embouchure characteristics as a prescription for teaching embouchure is the identification of a consistently superior mode of performance employed by experts. One electromyographic study of brass embouchure (Isley, 1972; Isley and Basmajian, 1973) concludes such a single mode of expert performance appears not to exist. Isley and Basmajian (1973, 143) observed, "The production of specific notes at specific volume on trumpet and trombone do not depend on exact patterns of activity in the muscles of the lips and buccinator (cheek)." Isley (1972, 173) commented, "The data obtained in this study show wide inter-subject and intra-subject variation and suggest that an individual may perform in many different ways tasks involving facial muscles." The conclusion was drawn that in the examination of expert players no one mode of embouchure performance could be identified as physically superior to another (Isley, 1972, 170; Isley and Basmajian, 1973, 145).

Another electromyographic study of trumpet embouchure (White, 1972; White and Basmajian, 1974, 1973) did find differentiation of some embouchure characteristics between advanced and beginning players. White (1972, 84) notes 1) advanced trumpeters have more muscle activity outside rather than inside the lips, while beginners show no difference in activity; 2) beginning trumpeters have greater activity in the upper rather than lower lip, while advanced players show no difference in degree of activity; 3) advanced trumpeters employ more constant embouchure muscle activity than beginners when performing slurred and tongued arpeggios, small-interval lip slurs, and short-spaced repeated notes; and 4) advanced players "demonstrate less difference in magnitudes of embouchure muscle activity between the last one-half second of preparation for the tone attack and during the tone than beginning trumpeters." White's (pp. 85-86) teaching recommendations derived from these findings include the following: 1) concentrate muscular tension outside rather than inside the lips; 2) encourage in beginners less muscle activity in the upper lip and more in the lower;

and 3) maintain a constant embouchure-set during performance of small-interval slurs and short-spaced repeated tones. The third recommendation as regards short-spaced notes can be viewed as possibly confounded by consideration of a breakdown of data within the study, however. White (p. 29) ranked his 18 subjects according to expertise reflected by years of private study, years played, and age. The first-ranked subject (Roy Stevens) ranked sixteenth in the amount of muscle activity variation between short-spaced notes (p. 67). A blanket recommendation to avoid such variation is therefore problematic and points to a general concern about recommendations being derived from averaged data, even if statistically significant.

White's (p. 84) conclusions are based on statistical significance. But his recommendations derived from those conclusions appear based on the assumption that a description of expert playing characteristics equates to a teaching prescription. An electromyographic study of silent speech movement in good and poor readers by Edfeldt (1960) suggests White's experimental conclusions could be viewed as symptoms of advanced and beginning playing ability rather than as a basis for instructional strategy. Edfeldt (p. 153) found that good readers in fact do engage in less silent speech than poor readers. After a detailed analysis of results, however, he concluded that silent speech was simply symptomatic of poor reading skill, was not of itself detrimental to a poor reader's performance, and should not be discouraged in an effort to match the characteristic of good readers as had been commonly prescribed (p. 154). Thus, an expert characteristic is viewed by Edfeldt as symptomatic rather than causal in nature.

The issue of the value of describing skilled performance is considered by Colley (1989) in a discussion of studies into skilled typing. She contends the model of expert typing derived from such research does not offer an explanation of how and why typists improve with practice to achieve expertise (p. 237). In other words, description of expert performance is not seen by Colley as offering insight into formulating a teaching strategy for development of expertise. Exactly how expertise is developed remains an open question. Salmoni (1989, 219) notes similarly that practice leads to skilled performance, but why it does so is still a mystery. Mackay (1982, 485, as cited by Colley, 1989, 244) criticizes researchers for adopting a strategy of examining what is conveniently examinable, with the result that there has been "...a concentration on the surface or muscle movement characteristics of different 'types' of skills, at the expense of the underlying mental processes that are involved in the control of muscle movements." Concerning physiological research into the playing process, Jacobs (Russo, 1973, 30) comments that

> when you study the functions, you study it after the fact - there is not a creative thought. We can make measurements as to what a man has done. We can find out what muscles are functioning. We can get electro-monographic studies, some of the work efforts of the musculature. We can find out many things; but we are not able with these tools of measurement to find out what the brain is doing.

In his electromyographic study of brass embouchure, Isley (1972, 22-25) reviewed research into the successful use of biofeedback in training the conscious control of a single muscle unit. He concluded,

> . . . it would appear that if the brasswind player understands the musculature of the face, and the functional relationship of facial muscles in brasswind performance, he may be able to analyze his technique and perhaps improve it (p. 25).

Thus an electromyographic study of the embouchure musculature of expert players would seem to offer the promise of instructional application for less-skilled players. Views challenging such a direct correlation have been noted, but there is also a later electromyographic study of clarinet embouchure by Basmajian and Newton (1974, 92) that points to the ineffectiveness of the strategy Isley envisioned. Less-skilled clarinetists were successfully trained through biofeedback to mimic the characteristic activity found in the buccinator muscle of expert clarinetists. Basmajian and Newton reported that when subjects then suppressed or recruited activity on the buccinator while playing, no audible or recordable change of tone resulted (p. 92); that is, no improvement toward expert performance occurred when an expert characteristic was mimicked by a less-skilled player.

<u>Research studies - imagery</u>

The recommendation at issue is that a trumpeter should know the pitch of a note before playing it and then rely on that pitch image to manage automatically the physical operation of the embouchure. As conscious thought is not directed toward the physical specifics of embouchure within such an approach, research into the physical characteristics of expert players would have no direct bearing on teaching strategy. It is not surprising, conversely, that researchers committed to examination of an expert's physical characteristics would not be inclined to consider the recommendation at issue within the scope of their research. Even if they had been inclined to take such a recommendation into account, there has been a serious barrier to their doing so. That barrier has been the standing of mental imagery within the realm of scientific empirical investigation.

An introduction to this issue is afforded by additional consideration of the electromyographic study of trumpet embouchure by White and Basmajian (1974). One finding earlier cited was that advanced players "demonstrate less difference in magnitude of embouchure muscle activity between the last one-half second of preparation for the tone attack and during the tone than beginning trumpeters (White, 1972, 84)." White and Basmajian (1974, 301) reflect on this finding with the following comments:

> Although no difference between advanced and beginning players was found on the duration of pretone embouchure muscle activity, players' proficiency level does affect pretone magnitude of activity. The pedagogical implication of this finding regarding what to teach is clear, although the question of how this might be taught is not answered. It remains a matter for theoretical consideration and subsequent research as to what method would be most effective for training the student to prepare the embouchure muscle activity at the same level as that to be used during the tone.

This writer interviewed White (7/25/89, Appalachian State University, Boone, NC) and asked him if having an auditory image of the pitch one wishes to produce prior to playing the note might theoretically be the means of encouraging a pretone-tone consistency in magnitude of muscle activity. He responded, "This may be. In fact, it is consistent with my own teaching approach. However, at the time of my research study, such a suggestion involving mental imagery would not have met the required empirical standard."

White's statement reflects an attitude toward mental imagery prevalent in the field of psychology from the rise to dominance of behaviorism in the 1920s until its subsequent decline in popularity that began slowly in the mid 1950s and gathered momentum during the period 1965-75 (Yuille, 1983, 264). Bell-Gredler (1986, 28-30) offers a summary of the rise of behaviorism. The behaviorist movement was launched by John Watson in 1913 as a reaction against the then prevailing focus of psychological research on introspection in the self-reporting of one's own thought processes. Watson sought to establish psychology as an objective, experimental science. This meant the study of observed behavior became the only valid research criterion. Thus, the behaviorists focused on the laboratory-controlled study of the relationship between stimulus and response, and rejected introspective, mentalistic methodologies which could not yield objective, replicable results.

Yuille (1983, 264) notes that, as a result of the dominance of behaviorism, imagery virtually disappeared from psychological research and theories in North America for over 40 years until behaviorism began to be viewed by the mid-1960s as unsuccessful in its attempts to explain and predict human behavior. Imagery research has re-emerged since as a part of the effort by now dominant cognitive psychologists to account for the complexity of human behavior. However, imagery research remains empirically problematic, as reflected by the following comments by Paivio (1988, 3-4):

> The study of imagery has always been plagued by the difficulty of finding a relatively direct and unambiguous observational criterion for imagery activity. This problem of operational definition is common to all inferential or mentalistic concepts and its consequences have ranged from outright rejection of such concepts in the behaviorist program to a variety of specific complications in the investigation of imagery. . . . the subjective nature of imagery makes it difficult to come up with a simple measure of the extent to which imagery is involved in specific tasks, a measure comparable, say, to verbal responses as indicators of language involvement.

As imagery involves an internal mental process, its consideration by empirical investigation will likely remain problematic. However, Williams (1981, 89) points out that music listening, performing, and composing skills cannot be considered "without implicating the role of music memory and storage of music imagery."

Studies involving pitch imagery by Bergan (1967, 1965) were conducted in the early period of the reappearance of mental imagery research. At the time, he was careful to note that

> the use of the concept of imagery does not imply a return to introspective psychology. On the contrary, imagery is regarded here as an intervening variable linked to observable behavior . . . (1967, 100).

Study results (Bergan, 1967, 106-107) demonstrated a correlation between pitch judgment and imagery in support of the following rationale (p. 99):

> . . . the activity involved in making judgments of pitch must utilize thought processes which for the most part do not include the use of words. Pitch is sound, not symbol, and the individual who attempts to make judgments regarding pitch must rely in his thinking on something other than verbal direction. The assumption advanced in this study is that that something is a mental representation of the sound itself: that is, a tonal image which closely approximates the actual experience of hearing. It is suggested that such an image acts as a standard against which to compare actual pitches being judged.

Recent research studies in brass pedagogy by Ross (1985) and Trusheim (1987) have involved imagery. Ross (1985) studied the effects of mental practice on 30 advanced trombonists. Such practice was described as "mentally playing the passage over a number of times without any physical movement or sound (p. 221)." Ross (pp. 227-228) notes results supported the conclusion that "a combination of physical and mental practice can actually produce improvement in performance equal to all-physical practice." The following research disclaimer was cited:

> Because mental practice is a cognitive technique that cannot be observed, there is no way of knowing exactly what the subject is thinking other than to ask specific questions after the experiment is over. Even so, the manner in which each subject mentally practiced the music probably can never be completely known or understood by the experimenter (p. 225).

The relationship of Ross' study to the recommendation at issue here is reflected by his instructions for mental practice, which included the following:

> Tempo: Use any tempo you wish but try to keep it steady to the end. Do not stop or go back to repeat any notes.
> Pitch: Try to "hear" each pitch but do not vocalize.
> Embouchure: Try to "feel" the movements of your embouchure but do not buzz your lips (Ross, 1985, 224).

Such instructions on embouchure are sympathetic to Reinhardt's (1964, 13) "sensation theory" that emphasizes "feeling" the embouchure setting, but such an emphasis is at odds with the recommendation at issue here which discounts conscious awareness of embouchure feeling, as reflected in comments by Jacobs (Bobo, 1981b, 45), "I don't care how my lip feels; I don't care how I feel. . . . my whole concentration is not on what I feel like or what I sound like, but what I want the audience to hear." Also, instruction by Ross concerning pitch in no way assures that an accurate pitch image is contributing to the ultimate performance result. Accurate pitch imagery is critical to the relationship between imagery and embouchure management here proposed. The observable behavior necessary to assume accurate pitch imagery is to require the subject to sing, hum, whistle, or buzz the passage in question correctly before playing it. These points have not been meant as criticism of Ross' study, but rather to demonstrate that the relationship between pitch imagery and embouchure management was not directly at issue in the study.

Ross (1985, 228) concludes that mental practice appears to contribute to skill development but that the question remains as to why it does so. A possible reason is suggested by results of an electromyographic study by Holdsworth (1974) investigating covert muscle activity in trumpeters listening to a recording of trumpet performance while observing the music being performed. Results indicated that covert activity in the fingers of the right hand was present as subjects listened to music performed (pp. 155-156); that is, electromyographic measurement of muscle activity in the fingers of the right hand indicated activity of which the subjects reported not being aware and that was not observable in review of a videotape that monitored subject hand and arm movement. (In the course of the experiment, the circumstance arose that the covert activity of the embouchure in addition to the right hand might be examined (p. 85); however, complications arose and the decision was made not to report results of the impromptu monitoring of embouchure activities for reasons noted by the researcher (pp. 121-124).) Holdsworth (p. 160) commented concerning study results, "Covert psychomotor activity in the musculature expected to be active in performing seemed to play a role in the observing of musical stimuli and acquiring of musical behavior." In mental practice, the subject's reaction to imagery may be physiologically similar to the reaction to observable stimuli studied by Holdsworth; that is, there may exist a subliminal muscular rehearsal or mimicry during mental practice of the behavior represented by the imagery involved.

Trusheim (1987) summarized his study of mental imagery in brass performance as follows:

> Artistic musical performance is externalized as skilled physical activity of the highest order, however, this outward manifestation is guided by complex internal processes which

> are personalized for each player. The objective of this study was to explore the potential of mental imagery as a component in the process of artistic performance in an elite group of orchestral brass players from five major symphony orchestras in the United States. Twenty-six respondents were interviewed face-to-face concerning the role and importance of mental imagery as an ingredient in their approach to performance (p. ii).

Current and retired players from the Baltimore Symphony Orchestra, the Boston Symphony Orchestra, the Chicago Symphony Orchestra, the New York Philharmonic and the Philadelphia Orchestra were interviewed. Trumpet respondents were Donald Tison, Charles Schlueter, Adolph Herseth, Vincent Cichowicz, William Scarlett, Philip Smith, Vincent Penzarella, Seymour Rosenfeld, and Donald McComas (p. 124). Complete interview transcripts were not offered. Rather, Trusheim summarized comments from all respondents within general discussions of the following topics: training and experience, mentors, warm-ups, tone production, musical expression and interpretation, conductors' imagery, mental rehearsal, and performance anxiety (p. iii). Trusheim does not specify the pedagogical recommendation at issue here within his discussion of these topics (pp. 140-302) or within his summary of existing mental imagery research (pp. 58-108). Respondent Vincent Penzarella's comments cited within the discussion of training and experience (pp. 150-152) are sympathetic to the recommendation, however, and will be discussed in the next chapter of this study. Trusheim (p. 328) does note that the great majority of respondents reported the ability to form an aural image of the sound they wished to produce. He comments further:

> The nature of sound production on the brass instruments also encourages the use of imagery in the sense of having to create a mental representation of a passage in order to ensure accuracy in pitch. Arnold Jacobs underscores this

> point with his comment about the similarities between playing a brass instrument and the process of singing. Brass players must rely on their ability to hear the pitch to be played in their minds in order to produce the correct note. This study suggests that the role of imagery is far broader than finding the correct note for these players (pp. 328-329).

Conclusion and summary

The recommendation at issue is that a trumpeter should know the pitch of a note before playing it and then rely on that pitch image to manage automatically the physical operation of the embouchure. A review of contemporary pedagogical opinion on embouchure revealed only occasional partial endorsements of the recommendation. The recommendation might therefore be characterized as outside the mainstream of pedagogical opinion.

No consideration of the recommendation was found in research studies related to embouchure. Such research has been dominated by the examination of the physical characteristics of expert players, these characteristics often then used as a basis for formulating instructional strategies for less-skilled players. The approach of equating description of expert characteristics with teaching prescription was challenged on the following points: 1) no research exists showing that such a strategy is effective (Hedden, 1987, 1981), while research exists suggesting that it is ineffective (Basmajian and Newton, 1974); 2) no superior mode of expert embouchure function can be identified to serve as an instructional point of departure for such a strategy (Isley, 1972; Isley and Basmajian, 1973); and 3) expert characteristics may be symptomatic rather than causal in nature (Colley, 1989; Edfeldt, 1960; Russo, 1973). Finally, lack of research consideration of the recommendation at issue may be in part attributable to behaviorist research standards dominating psychological inquiry from 1920 to 1970 that dismissed mental imagery as too introspective or mentalistic to be a legitimate subject of investigation.

CHAPTER 4

SUMMARY AND IMPLICATIONS

Summary

The purpose of this paper was to consider theoretically the use of pitch imagery in the management of trumpet embouchure. Pitch imagery was described as a component of the auditory imagery representing a general musical performance goal, with pitch imagery assumed to be that component most directly related to embouchure function. At issue was the following recommendation: a trumpeter should know the pitch of a note before playing it and then rely on that pitch image to manage automatically the physical operation of the embouchure.

A review of current psychomotor theory and related research lent validity to the recommendation. Pitch imagery might be characterized as a "response specification" (Schmidt, 1975, 232), or "pre-cuing" (Summers, 1989, 56; Shaffer, 1981, 327), or "preprogramming" (Holding, 1989, 283) in the setting of prestructured commands operating a motor program in an automatic, open-loop fashion described within schema theory (LaBerge, 1981; Schmidt, 1975). The fine-tuning of skill by feedback evaluation and error correction during performance is suggested by research (for review see Winstein and Schmidt, 1989, 26-37) to be automatic and unconscious in nature. Hence, conscious attention during performance may remain on pitch imagery rather than on evaluation of embouchure activity. Such reliance on pitch imagery and abandonment of conscious consideration of the physical specifics of embouchure operation could be termed "letting go" in the manner described by sports psychologist Charles Garfield (1984). Garfield (p. 184) comments that letting go means learning "to trust the complex subconscious mechanisms that ultimately determine peak performance."

A review of contemporary pedagogical opinion on embouchure revealed only occasional partial endorsements of the recommendation at issue. The recommendation might therefore be characterized as outside the mainstream of pedagogical opinion. No consideration of the recommendation was found in research studies related to embouchure. Such research has been dominated by the examination of the physical characteristics of expert players, these characteristics often then used as a basis for formulating instructional strategies for less-skilled players. The approach of equating description of expert characteristics with teaching prescription was challenged on the following points: 1) no research exists showing such a strategy is effective (Hedden, 1987, 1981), while research does exist suggesting it is ineffective (Basmajian and Newton, 1974); 2) no superior mode of expert embouchure function can be identified to serve as an instructional point of departure for such a strategy (Isley, 1972; Isley and Basmajian, 1973); and 3) expert characteristics may be symptomatic rather than causal in nature (Colley, 1989; Edfeldt, 1960; Russo, 1960). Finally, lack of research consideration of the recommendation at issue may be in part attributable to behaviorist research standards dominating psychological inquiry from 1920 to 1970 that dismissed mental imagery as too introspective or mentalistic to be a legitimate subject of investigation.

Implications

The recommendation at issue is that a trumpeter should know the pitch of a note before playing it and then rely on that pitch image to manage automatically the physical operation of the embouchure. In implementing the recommendation as a teaching strategy, the instructor would view the student as needing the same pitch awareness as a singer; that is, by memory and/or sight-singing ability, the player must have an accurate image of the pitch of each note to be played before playing that note, and must also have as an essential point of reference an image of the pitch of the first note in any passage to be played. (As regards initial pitch references during private practice, the trumpet may be used as a pitch pipe. Slightly slapping the cup of the mouthpiece with the palm of the hand will sound the instrument's fundamental pitch; for example, c-natural with no valves depressed, b-natural with the second valve depressed, etc. The c-natural fundamental is truest to actual performance pitch, as lower fundamentals tend gradually to give a flatter pitch in relation to performance pitch. Therefore, singing or imaging the interval from c-natural to the initial pitch needed would likely be most desirable.)

Viewing a trumpeter as needing a singer's pitch awareness is sympathetic to recommendations by Kodaly (Hargreaves, 1986) and Gordon (1985, 1980). Concerning Kodaly's system of music teaching, Hargreaves (1986, 221-222) notes,

> Kodaly's primary concern was with the development of aural imagination, or the 'inner ear', and he felt strongly that this should be accomplished through singing before there was any introduction to instrumental playing: in fact he objected to

teachers' frequent over-reliance on the 'help' of an instrument in sight-reading.

Gordon (1985, 34) is concerned with the ability to "notationally audiate" or mentally hear music seen in notation when the sound is not physically present. Gordon (1980, 5-6) comments:

> It is futile to try to precede audiation with theoretical understanding; to do so prevents giving comprehensive musical meaning to the (notational) pattern. The error is evident in the wind instrument performer who cannot tonally audiate what is seen in notational form but nevertheless manipulates keys or valves on a music instrument as dictated by the letter names of the notes. Because a wind instrument does not have fixed pitches as compared to a keyboard instrument, the limitations of the performer who indulges in such musically perfunctory activity become obvious when he is unable to adjust pitches for purposes of good intonation. To read music on a wind instrument in this way is similar to copying a text on a typewriter which is designed for a language the typist does not know.

Gordon (pp. 6-7) continues,

> Just as students learn to read and write a language after they have acquired a functional vocabulary of words, so students learn to read and write music, that is, notationally audiate, after they have acquired a functional vocabulary of tonal patterns and rhythm patterns.

He concludes,

> When a student has developed a sense of tonality, a sense of meter, and a vocabulary of tonal patterns and rhythm patterns to the extent that he can sing in tune and with acceptable melodic rhythm in at least major and minor tonalities and in usual duple and triple meters, he is ready to begin the study of a music instrument (p. 233).

Trusheim (1987, 150-152) reports that New York Philharmonic trumpeter Vincent Penzarella was trained in a manner sympathetic to the views of Kodaly and Gordon just cited. Trusheim (p. 150) quotes Penzarella as follows:

> I was not brought into music the way most people were brought into music. I learned music, I did not study the trumpet. I studied solfeggio, dictation, aural harmony, theory and harmony, and all the arts away from the instrument . . . .

Trusheim (p. 151) notes that when Penzarella began studying trumpet he was given only a mouthpiece and a valve casing to practice fingerings. Therefore, in Penzarella's words, "All I could do is pick up the mouthpiece and buzz do-re-mi as my eye took information from the page (p. 151)."

Gordon (1980) has formulated a learning sequence in music designed to help develop the ability to notationally audiate, and hence the ability to sight-sing. Such ability is one means of facilitating the recommendation at issue. Another means is recall or memorization of the melodic pattern to be played. In this instance, the instructor does not rely on the student to be able to sight-sing, but rather as a prerequisite to playing a passage requires that the student first learn to sing the passage by rote imitation of the teacher. When the student can sing the passage accurately, he may then play it. Williams (1981, 91-92) points out that teaching such melodic memorization is notoriously difficult, as short-term memory can normally hold only four to seven melodic tones for potential transfer to long-term memory that would then allow more permanent recall of the pattern. His review of melodic memory research suggests memorization is aided by initially slowing the tempo, limiting the number of tones to remember, and limiting the time length of the passage to seven seconds or less (p. 91). Being faced with such a difficult process as a prerequisite to playing would suggest that music once learned should often be replayed rather than discarded. The goal in such a circumstance might be that the majority of instructional (or practice) time each day would be spent playing music previously learned. Proportionally less time might be spent on learning new music as one's known, or permanent, repertoire increased to the point of allowing needed variety in choosing music to play each day.

Reliance on a singer's awareness of pitch (and, hence, sight-singing ability and melodic memorization) may be viewed by many trumpeters as too limiting, too troublesome, and too radical a departure from standard instructional practice. A still prominent pedagogical view is offered by Petzold (1961, as cited by Holdsworth, 1974, 33) in noting that, in contrast to the vocalist, "the instrumentalist reacts in terms of tone placement and learned fingerings, (and) may never 'hear' the note prior to performance since he is reacting in a more precise, mechanical fashion." Faith in this assumed "more precise, mechanical fashion" is common in brass pedagogy, and as long as that faith continues, the recommendation at issue is unlikely to influence traditional instructional practice. Current research into psychomotor skills suggests, however, that such faith may be misplaced.

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