How do saxophonists communicate through bodily behavior? A contribution to embodied performance pedagogies

Nádia Moura[1][0000-0002-4618-4146], João Paulo Vilas-Boas[2,3] [0000-0002-4109-2939] and Sofia Serra[1][0000-0001-7052-860X]

[1] Catholic University of Portugal, Research Centre for Science and Technology of the Arts, 4169-005, Porto, Portugal
[2] Centre of Research, Education, Innovation and Intervention in Sport, CIFI2D, Faculty of Sport, University of Porto, 4200-450 Porto, Portugal
[3] Porto Biomechanics Laboratory, LABIOMEP-UP, Faculty of Sport, University of Porto, 4200-450 Porto, Portugal
nmoura@ucp.pt, jpvb@fade.up.pt, sserra@ucp.pt

Abstract. Bodily movement is at the heart of high-quality performance and deserves proper attention in instrumental education curricula. This study presents an analysis of the bodily behavior of professional and university-level saxophone players (*N*=20) conducted with the aim of developing pedagogical cues on embodied communication and expression during music performance. Participants performed five excerpts of the classical saxophone standard repertoire while motion capture, audio, and video data were recorded. A systematic observational procedure was carried out to analyze the relationship between movement and music, including gesture codification and score annotation of each of the 100 performance recordings, and further comparison between participants was made. Five gestural trends were extracted, related to expressive communication, pitch contour influence, rhythm and pulse influence, technique facilitation strategies, and full-body behaviors. Findings suggest saxophone players use gestures and postures as a resource for expressing significant musical locations, aiding perception of musical elements, and facilitating technical challenges. These insights contribute to the development of an embodied approach to instrumental teaching and learning, promoting body awareness, communicative and facilitative skills through movement education.

Keywords: Saxophone Performance, Embodied Pedagogy, Gestural Communication, Music Education.

1 A Framework for Embodied Music Performance Pedagogy

The theory of embodied music cognition puts emphasis on the body as mediator between mind and matter, meaning and environment [1-2]. Our perception of the world is built upon the resulting experiences of having a living body and its sensorimotor

capacities, which are in themselves embedded in a larger biological, psychological and cultural context [3]. Activities such as music performing or listening deploy the same neural mechanisms involved in motor activity [4], supporting that the bodily dimension is, more than a representation, an actual part of experiencing Music [5-6]. Cognition is, therefore, not restricted to mental processes occurring in the brain – rather, it involves a simultaneous interaction between perception, action and conception:

> *"When we hear a musical performance, we do not just "think", nor do we do just "hear": we participate with our whole bodies; we construct and enact it. We feel melodies in our muscles as much as we process them in our brains – or perhaps more accurately, our brains process them as melodies only to the extent our bodily extended schemata render that possible* [6, p. 47]*."*

Embodied pedagogy is defined as "melding of the physical and mental into the fabric of learning [7, p. 332]". Knowledge construction results from the unification of mind and body in learning experiences where the subject acts on the environment, but is also concomitantly shaped by it, hence rejecting the traditional Western dualisms envisioned in Platonic and Cartesian philosophical perspectives [7-8]. The idea of potentiating learning through action and sensorial activation is described in Dewey's schooling through educative experiences [9], Merleau-Ponty's embodied knowledge [10], Gardner's bodily-kinesthetic and spatial intelligences [11], among other works of renown pedagogues.

In music education, Dalcroze was one of the first to focus on the body as central in music learning and teaching, associating bodily awareness and gestures with the perception of musical elements such as rhythm, auditory training and creative improvisation [12]. Willems explored rhythm as inherent to quotidian activities of human life and its qualities as the basis for an education model where children live rhythm through their bodies, being able to further imitate it and apply it in artistic creation [13-14]. Other examples comprise Orff's pedagogy, where rhythmic imitation exercises based on movement are used in group music contexts, and Schafer's position on how bodily movement in association with cyclic sounds stimulate the child's motor coordination, as well as listening with the body, implying the activation of all five senses in music perception [14-16]. Recently, Burns [17] introduced a performative approach to teaching music theory, by motivating singing and dancing students to apply class contents in their practice, through the creation of compositions, arrangements, or choreographies. Although targeted at teaching-learning music theory, these references share useful guidelines on how to move with the music, evoking the coupling of kinesthetic and cognitive skills lacking in instrumental performance pedagogy:

> *"…how many musicians' practice routines include time for improving their expressive body movement and facial expression? Although these things are certainly extramusical and need not be addressed in practice sessions as other musical competencies are, they are, nevertheless, important skills. In fact, they may be critical to performance success* [18, p. 165]*."*

Concerning instrumental pedagogy, bodywork is introduced in two principal domains: physical health and expressivity. On the first, health programs designed for

musicians have been implemented encompassing physical (such as posture optimization, injury prevention) and psychological contents (performance anxiety management) [19-20]. Workshops and courses focused on kinesthetic awareness are nowadays accessible, including Alexander Technique [21], Body Mapping [22], which provide a broader view on the role of the body, offering some insights into expressive movement education. The domain of expressivity comprises bodily behavior connected to performer's communication, involving gestures and postures that embody interpretative intentions (e.g., musical elements, emotions) [23-26] and visual cues to other co-performers [27] or to the audience [28-29]. This matter seems to be commonly neglected in instrumental learning, as divided opinions emerge: while some playing schools recommend avoidance of expressive, unnecessary movement to achieve best results [30], others encourage expressive performative gestures under the argument that artistic interpretation should not be wasted [31]. Yet, determining which gestures have a significant role in performance is not as simple, as: a) these assume functional multiplicity – a gesture may assume one or multiple purposes depending on its context, and b) gestures overlap and bridge between each other – one gesture may be supported or anticipated by others, therefore its understanding depends on a broader perspective [32]. For example, in piano performance, the same head, face, gaze, and trunk gestures are used to communicate with others, express ideas, and facilitate melodic, harmonic, timbre, and dynamics by accompanying sound-producing gestures inherent to such passages [33]. The gesture of hitting a key involves not only finger movement, but also hand, arm and upper body, which assume a supportive role of the trajectory and velocity of the finger [32]. In this sense, by inhibiting gestures considered needless to technical accomplishment, teachers may be preventing students from improving their execution. Thus, it seems movement education in music contexts could benefit from a more holistic approach – an embodied performance pedagogy –, entangling aspects of motor control or injury prevention with the work of the body in consonance with aesthetic, interpretative objectives that make a performance unique.

Gestures often reflect structural parameters of music, suggesting they are related to the performers' knowledge on music analysis, consequently applied in their interpretative intentions [34-35]. In clarinetists, bell motion associates with melodic phrasing, dynamic and harmonic transitions [34], whereas in pianists head movement communicates different expressive modes and structural features [24, 36] like rhythmic sections, main themes or conclusive chords [37]. Moreover, gestures are effective in communicating emotional content of pieces [23, 38]. Alike other skills, musicians' body movement is highly conditioned by the instruments' technique and posture of playing [39], hence, systematic gestural repertoires, developed in consideration of each musical instruments' particularities, may constitute beneficial pedagogical tools to raise body consciousness and provide effective feedback on communication and expression [37].

Our main goal is to provide an innovative contribution targeted at pedagogical ends, towards the development of communicative and expressive guidelines in saxophone performance, possible of being extrapolated to other wind instruments. In this study, we present a systematic description of the bodily behavior of saxophone players in relation to the different musical excerpts performed, highlighting the most recurrent trends within the group. The analysis included multimodal data (audio, video, and

motion capture) of one hundred performance recordings. We address the following research questions: How do saxophonists move when performing? Although expressive movement carries a high level of idiosyncrasy, is it possible to identify transversal trends among performers, linked to the same musical contents? If so, how can these trends be extrapolated to other performative situations?

2 Methodology

2.1 Participants

Twenty volunteer participants (9 female), saxophone players, with ages ranging from 20 to 41 years (M= 26.3, SD= 5.4), were invited based on the criteria of having an established professional career (n=12) or attending superior-level degrees in saxophone performance (n=8). Additionally, a minimum of 10 years of saxophone practice was required, counted from the start of formal music education in official schools (M: 16.9, SD: 5.6 years). The participants came from different academic backgrounds, including studies in Portugal (n=8), Portugal and the Netherlands (n=9), Portugal and Spain (n=1), Portugal and Belgium (n=1), and Portugal and Austria (n=1).

Ethical approval to conduct this study was granted by the Ethics Committee for Health of the Portuguese Catholic University (CES-UCP) under protocol number 137/2021. Participants were given a written informed consent describing the study, which they read and signed before the individual recording sessions.

2.2 Materials

Motion capture data was recorded using an optical-electronic retroreflective system with 9 Vicon T40S-NR18 infrared cameras (Vicon Motion Systems Ltd., UK) at a sampling frequency of 240 Hz. A total of 58 spherical retroreflective markers were used, placed at the body landmarks illustrated in Figure 1, allowing to reconstruct a full-body 3D model of the subject. Nine other markers were fixed to the instrument allowing to also capture its movements (Figure 1). Audio signal was recorded with a ZOOM H4n Pro (Zoom Corporation, Japan) and regular video with a Canon EOS 100D (Canon Inc., Japan) with a 18-55mm lens (frontal plane), and a Blackmagic pocket cinema 6k (Blackmagic Design Pty Ltd., Australia) with a 24-70mm lens (lateral plane).

The selection of musical excerpts at study derived from a preliminary classical saxophone repertoire survey including programs of saxophone competitions, reference schools, and cited works in the literature. This resulted in a total of 29 pieces retrieved and analyzed, from which five excerpts were extracted considering the need of including contrasting compositional styles, techniques, and difficulty levels: E1: *Allegretto scherzando* from Concerto in Eb, Op. 109 (bars 40-66) [40]; E2: *Andante* from Concerto in Eb, Op. 109 (bars 81-103) [40]; E3: Entrance from Rapsodie (bars 14-35) [41]; E4: Entrance from 3rd movement ("*with gaiety*") of Sonata (bars 1-74) [42]; E5: Transition section from Concertino da Camera (bars 62-121) [43].

2.3 Procedure

Individual data collection sessions took place at the Motion Capture Studio of Universidade Católica Portuguesa over a 6-month period. The average duration of each session was two and a half hours. Approximately one month before the date chosen to record, participants received the informed consent along with the musical excerpts to study. All participants were familiar with the excerpts.

Prior to the recording session, participants signed the informed consent form while the equipment was calibrated. Retroreflective markers were then attached to the performer's body and instrument according to the designed setup. Followingly, participants moved to the floor-marked location, centered with the equipment, and were instructed about the recording sequence repeated for each excerpt. Each excerpt was repeated as many times as the participants would like, and the preferred take for study was chosen by them post-recording. Participants performed alone, with no audience but the research collaborators in the room.

2.4 Data Analysis

Video and audio data were edited into a double-screen format and motion data processed (labeling, smoothing, and gap-filling); all were synchronized from the initial point where a clapperboard was used. Events corresponding to the excerpt's phrase division were introduced in the motion files. One hundred files were considered for the study: twenty participants performing five excerpts each.

The systematic observation procedure applied to each excerpt consisted of a) initial exploratory visualization of the sample, b) annotation of gestures observed in the musical score using the coding system and production of descriptive synopses, c) comparison of resulting scores and synopses per excerpt and d) identification of key locations and common gestural patterns. Articulating gesture descriptors with musical scores and implementing coding or symbol systems are common procedures in the qualitative study of musicians' bodily movement [44-47]. Still, most of those studies restrict to video analysis [44-47]. Differently, we employed 3D motion files synchronized with audiovisual tracks as they provide enhanced analysis advantages: alternative plane perspectives, trajectory drawing, visualization of smaller gestures and exportation of the graphical examples of the gesture repertoire of saxophone players we present further on. The gestural coding system was developed from previously established gesture types in other musical instruments [26, 35, 45] and taking into consideration the results of our preliminary video-based study [47]. It was also open to the integration of new types emerging from this new database. Its final version comprised 15 gesture types: bell lift, bell circle, bell sweep, head nod, left shoulder elevation, left arm flap, left wrist flexion/rotation, trunk flexion, trunk lateral inclination, knee flexion, feet stepping, feet elevation, medial-lateral sway, anterior-posterior sway, and body rotation – side turn. In the end, a descriptive analysis of the performers' bodily behavior was produced.

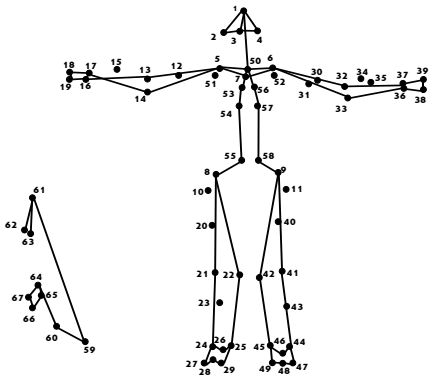

Fig. 1. Marker configuration used for this study: head (markers 1-4), trunk (m. 5-7, 50-58), hips (m. 8-11, 55, 58), upper limbs (m. 12-19, 30-39), lower limbs (m. 20-29, 40-49), and saxophone (m. 59-67).

3 Findings and Discussion

The first conclusion drawn from this analysis was that there was enough inter-performer consistency to support the extraction of the subsequent selection of gestural trends of the group (only manners occurring in at least 50% of the saxophonists were considered for presentation). Throughout the process it was clear that the bodily behavior of the participants was much more related to musical syntax (e.g., dynamics, rhythm) than compositional style or epoque of the excerpts (e.g., Russian Romanticism), since all gesture types were repeated across excerpts (apart from trunk lateral which was idiosyncratic of only two performers), and similar motion patterns were recurrently identified in equivalent contexts of diverse excerpts (examples defined over the next paragraphs). This tendency aligns with the findings of Davidson [29], who observed pianists used a core movement vocabulary across pieces of different epochs, although variations appeared in some of the works – these variations related to musical structure (e.g., key changes, crescendo) and emotional content (e.g., intense, joyous) [29]. From another perspective, excerpts of the same period (Romantic) have displayed different motion values, suggesting pianists' movements depend on technical and structural parameters of the pieces [37]. Facing this point, an initial idea of presenting a description of performative movements per excerpt was replaced by the grouping of gestural trends observed across excerpts in analogous musical contexts (examples of these are presented in Figure 2).

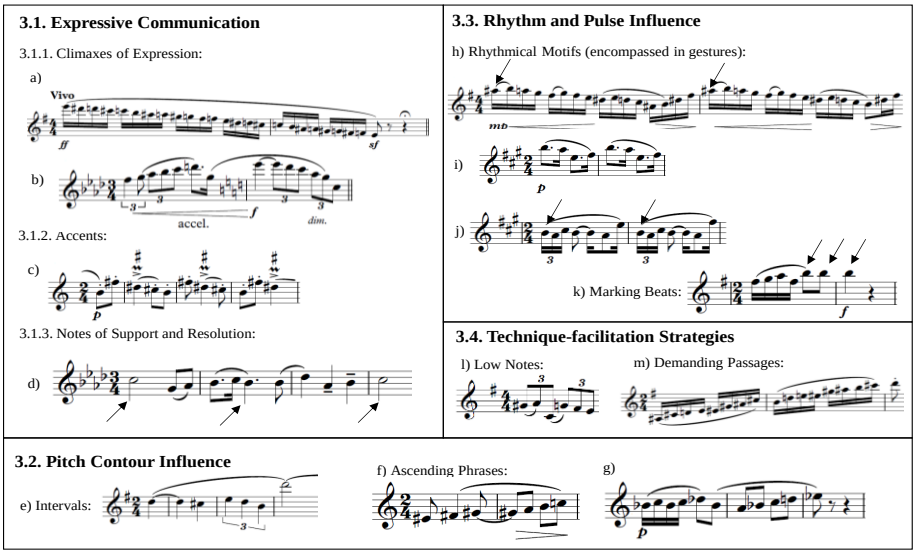

Fig. 2. Representative examples of the musical contexts described throughout the findings: a), b), d), h), k) and l) are retrieved from Glazounov's Concerto [40] and correspond, respectively, to bars 65-66, 99-100, 85-88, 53-54, 58-59 and 42; c) and g) are retrieved from Creston's Sonata [42] and correspond, respectively, to bars 14-17 and 72-74; e), f) and m) are retrieved from Ibert's Concertino da Camera [43] and correspond, respectively, to bars 78-81, 120-121, and 114-116; and i) and j) from Debussy's Rapsodie [41] and correspond, respectively, to bars 31-32 and 33-34.

3.1 Gestural Trend 1 – Expressive Communication

The intention of emphasizing significant musical locations where performers concentrated their interpretative ideas translated into corresponding gestural manners. The communication of musical ideas through the body in accompaniment to the sound was identified in three contexts:

3.2.1. Climaxes of Expression. Expressive, powerful locations such as full of tension endings, *sforzandos*, or *crescendo* climaxes were evidenced by 90 to 100% of the participants across excerpts. These locations were connected to bell gesture types (lifts, circles, and sweeps) and left-arm gesture types (flap, shoulder elevation, wrist flexion/rotation), full-body extension, and, in a smaller number of cases, feet elevation, and side turn. Examples include the ending of E1, a descendent chromatic scale with *Vivo* indication, culminating in a final *sforzando* (Fig. 2 ex. a, Fig. 3), and in E2, the two *crescendos* comprising an ascending interval (a 3rd and a 6th, respectively) leading to high register notes of the saxophone (Fig. 2 ex. b), where sax players flexed their knees and trunk to propel the following extension of the body to reach the high note; depending on the player, this extension involved lifts of the bell, shoulder, feet and, not as regularly, leaning backward of the trunk.

3.2.2. Accents. Defined as an effect of emphasizing certain notes through dynamics in relation to other non-accentuated notes, 90% of the participants translated fast accents into jerky head nods, at times accompanied by knee flexion and trunk flexion, bell lifts, and flaps. E4 was unquestionably representative of head nodding in accents (Fig. 2 ex. c): it was the only excerpt where most sax players performed this gesture type repeatedly.

3.2.3. Notes of Support and Resolution. Across excerpts, 75 to 100% of the participants highlighted notes to which they conducted their phrasing, whether in the middle of a phrase or at its resolution. Most recurrent gesture types used in this context were: left wrist flexion/rotation, shoulder elevation, flap, bell lift and feet lift (often synchronized), side turn, trunk flexion, as well as full-body extension motion. Examples were extracted from E2, where long legato phrases implied direction towards support notes (Fig. 2 ex. d), and sections of E4 and E5, where phrases resolved onto longer notes.

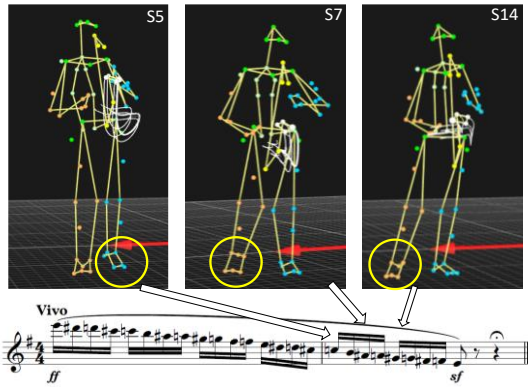

Fig. 3. Examples of three players executing bell motions (instrument trajectories are highlighted), body extension, and feet elevation in bars 65-66 of Glazounov's Concerto [40].

Behaviors contained in 3.2.1. and 3.2.3. are consistent with others detected in different instrumentalists, as climaxes, modulations, phrase boundaries, and cadential resolutions have been identified as points where performers move more – the overall quantity of motion is higher [48]. The more expressive a musician intends to be, the larger amplitude of movement he/she performs [25]. Interestingly, this variable often associates with the amount of expressiveness conveyed by the movement to the audience [45, 49]. Alike clarinetists [34], saxophonists tend to execute bell motions in expressive passages and key musical phrases. Still, in saxophone playing, bell lifts are more frequent than bell circles, different from what occurs in clarinet playing (Teixeira et al., 2014; Wanderley et al., 2005). On this topic, most gesture types identified (e.g., swaying motions, knee and trunk flexion, feet elevation, flap, etc.) are common to other instruments' practice [35, 46], with exception of feet elevation and side turn. It could be possible that the fact that the saxophone's weight is supported by a neck strap allows for slightly higher freedom of movement when compared to the clarinet or the flute, which are fully supported by the arms.

Regarding 3.2.2., the impulsive gestures observed in accentuated notes meet the established definition of sudden muscle contractions followed by immediate relaxation, typically resulting in corresponding impulsive sounds – defined by an abrupt attack followed by a decay [50]. These patterns have also been detected in percussion [51], piano [52], and bowed string instruments [53]. However, in these instruments, impulsive gestures are directly related to sound production points (bow, mallet), whereas in wind instruments the effective sound production of an accent relates to the coordinated use of the tongue, airstream, and embouchure position [54], and not properly head nodding or trunk flexing. This points to a facilitating or accompanying nature underlying impulsive gestures in saxophone playing, rather than a sound-producing one.

3.2 Gestural Trend 2 – Pitch Contour Influence

The influence of pitch contour was not always linear (naturally, it would be impossible for participants to constantly move up and down according to the melodic line), however, in the discussed sections, movement and pitch were particularly associated where significant changes in pitch contour occurred (sudden big intervals and ascending scales). Here, the gestural trend observed is defined as the relation between the height of the musical notes and the one of the performers' centers of gravity – when pitch rises, the player extends his/her body and vice versa. Examples of ascending melodic lines occur in the ending of E2, E3, E4, and E5 (Fig. 2 ex. f and g), where 70 to 100% of the performers (depending on the excerpt) executed similar ascending motion patterns, where they would flex their knees (sometimes accompanied by the trunk) and start extending knees and trunk until the last note, integrating in this extension gestures such as lifts and circles of the bell, sideways turns, left arm gesture types, and feet elevation (Fig. 4). In relation to sudden big intervals, in the melodic line of the first section of E5, where up and down intervals (5ths, 6ths, 10ths) are constantly presented (Fig. 2 ex. e) – 90% of the performers mirrored this musical gesture in their bodily behavior – extension motion in ascending pattern and flexion motion in descending pattern.

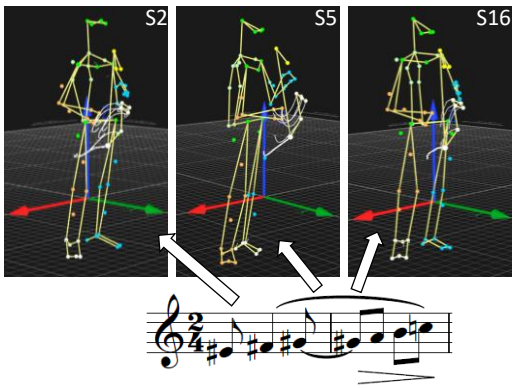

Fig. 4. Three players executing ascending motions in bars 120-121 of Ibert's Concertino da Camera [43], ending in extended position including feet elevation and bell lift (instrument trajectories are highlighted).

In accordance with this trend, the accompaniment of the melodic line with bodily movement is described through the action of rising/lowering knees in clarinetists and flutists [46] and of mirroring musical direction and intervals performed by the hands with head, face, and trunk, in pianists (Poggi, 2006).

3.3 Gestural Trend 3 – Rhythm and Pulse Influence

Rhythm, or timing, was a considerable factor of influence in movement. Firstly, an interesting interdependence between motion velocity and the music's movement was constant, in the sense that the velocity of physical movement was related to the pulse of the music. Slow-paced, melodic excerpts (E2, E3) induced lower velocity and higher fluency of movement (more continuous and uninterrupted). Here, the full-body sway functioned as a base layer of movement, on which smaller gestures were integrated in (in E2 and E3, 20 participants performed mediolateral sway, 5 additionally performed anteroposterior). The continuous movements observed in slow excerpts align with the category of "sustained movements" [50], defined as comprising continuous transfers of energy from the body to the instrument (e.g., continuous bowing, singing) and resulting in sustained sounds (Godøy et al., 2017; Gonzalez-Sanchez et al., 2019)]. The other excerpts (pulse indication: 112, 126, and 160 bpm) incited speedier general motion (sway) and gestures, although not as linear – sometimes moments of energic movement were interposed with moments of postural stabilization (in technically demanding passages), where performers assumed static postures or executed small gestures marking beats or support notes, which translated into picks of acceleration in the movement (rarely observed in slower excerpts). In the study conducted by Massie-Laberge and colleagues [37], the softer, slower rhythm excerpt allowed pianists to emphasize several structural parameters, even when performing in immobile condition. Similarly, Teixeira and colleagues [34] suggested the Brahms clarinet excerpt, with more complex harmonic and melodic content, provided more room for expressiveness than the Mozart excerpt. It is possible that slower, smoother excerpts may leave more space for physical expression in saxophone players as well.

Secondly, gestures were regularly used as a strategy to feel rhythmical elements. 55 to 85% of the participants, across excerpts, encompassed rhythmical motifs into gestural trajectories and entrained into repeated rhythmical patterns by performing the same gesture cyclically (sway, turn, trunk and knee flexion, bell lift, and circle, head nods, feet elevation, flap). For instance, in passages of E1 and E5 comprising continuous fluxes of ascending and descending sixteenth notes (Fig. 2 ex. h), performers repeated gestures in the same time intervals. In E3, in the rhythmic pattern of bars 30-31 (Fig. 2 ex. i), 75% of performers started swaying and turning sideways in pulse (Fig. 5) after several bars where movements were overall long and large in amplitude. In the same excerpt, participants often executed bell circles, accompanied by trunk and/or knee flexion, coincidently with repeated rhythmic motifs: triple semiquaver triplets of bars 19-20, descendent semiquavers of bars 21-22 and 25-26, and doubled melismatic motif of bars 32-33 (Fig. 2 ex. j). Finally, 100% of the performers used gestures to mark strong beats across excerpts (wrist flexion/rotation, flap, feet tapping, and knee and/or

trunk flexion). For example, in E1 all participants highlighted the three repeated Bs of bars 58-59 (Fig. 2 ex. k, Fig. 6).

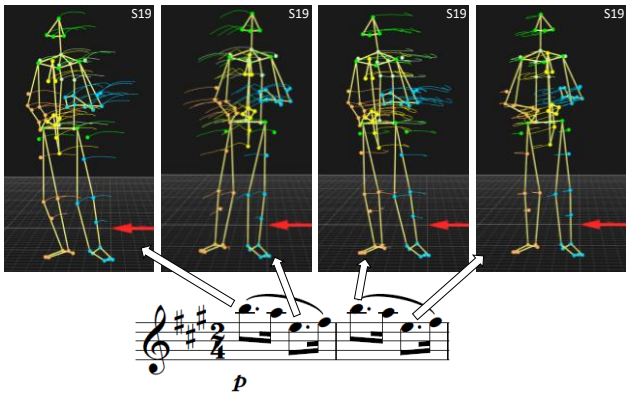

Fig. 5. Change of sway direction in each beat (body-markers trajectories are highlighted). Excerpt retrieved from bars 31-32 of Debussy's Rapsodie [41].

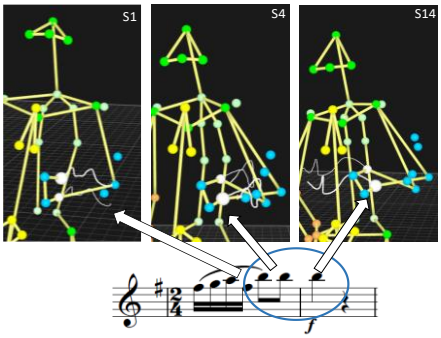

Fig. 6. Different players (1, 4, 14) executing wrist flexions and/or rotations (wrist markers trajectories are highlighted) rhythmically in each B4: trajectory line goes up in 1st B, down in 2nd, and up again in 3rd (upwards motion in beat and downwards motion in upbeat). Excerpt retrieved from bars 58-59 of Glazounov's Concerto [40].

In line with these observations, the metrical structure has been identified as a shaper of performers' movement, leading to the execution of gestural patterns according to rhythmical grouping [32, 35]. It has also been previously discussed that musicians use gesture types such as foot and toe tapping, bell vertical movement, rocking and swaying, as aids to keep rhythm and sense time [35, 46]. For example, pianists executed head shakes every two quarters, analogously to the rhythmical structure of the music, in what seemed to be a facilitating strategy of hand motion [32]. Our findings suggest saxophone players adopt similar rhythmical-related behaviors. Curiously, when prevented from naturally moving, clarinetists' timing perception was altered, leading to a tendency of rushing time [35], which indicates bodily movement may be intrinsically connected to the feeling of pulse, and, ultimately, preventing students from moving

with the music may be a synonym to preventing them of fully entraining into the rhythm.

3.4 Gestural Trend 4 – Technique-facilitation Strategies

Technique-facilitation gestures appeared in three situations related to particularities of saxophone playing, hence supporting the association with such adaptative function:

3.4.1. Attack of low register notes (Bb2 to C3). In the three situations analyzed from E1, E2, and E5 (Fig. 2 ex. l), respectively 80%, 50%, and 100% of the participants changed into a flexed position, involving knee and/or trunk flexion to attack low notes; in a small number of cases, shoulder elevation and flaps were executed as if to push the attack.

3.4.2. Technically demanding passages (continuous semiquavers and harmonics). In fast semiquaver passages (Fig. 2 ex. m), all participants remained in a more constraint position, also with knee and/or trunk flexed and restricted overall movement, apparently for focus and energy-saving purposes; in addition, small steps (forward, backward, and sideways) seemed to contribute for the postural stabilization of some players. Concerning *altissimo* notes, an isolated context (E5) included an optional passage of high-register harmonics: here, only 4 performers opted to do it and adopted a static position, in contrast with the other 16, who played the inferior octave and kept moving.

3.4.3. Breathing. Incited the flexion of knees and/or trunk for all participants, and in some cases the flap.

The adoption of static postures across demanding passages was reported in clarinet players, and it is suggested that this movement limitation may prevent fatigue and injuries, as well as facilitate precise execution in difficult passages [35, 55]. With pianists, Massie-Laberge and colleagues [37] observed that it was in the most technically challenging excerpt of the study that motion patterns across individuals were more similar, proposing the movements needed for technical accomplishment leave less space for individual expression. About breathing, Wanderley [56] identified a tendency of moving the instrument down and lifting it shortly afterward executing respirations in clarinetists; in the same study, the immobile performances were said to cause difficulties in breathing. No information was found on the attack of low notes.

3.5 Gestural Trend 5 – Full-body behaviors: Postures and Sway

From this analysis, it was possible to conclude a high portion of the saxophonists' bodily behavior revolves around a duality between open postures (higher center of mass, extended body, lifted bell or feet) versus closed postures (lower center of mass, flexed body often leaning forwards or sideways). Open postures were repeatedly adopted in phrase endings where the melodic line and/or dynamics ascended and climaxes, notes of interest, locations where the music was more intense or exposed. Closed postures took place in moments where the music was constrained, sensitive or mysterious, such as phrase beginnings from lower notes, fade away effects, passages generally

representing softer dynamics (*pianissimo, piano*), or, with different purposes, technically demanding sections. An example of this duality occurs in the second section of E5, where bars of semiquavers are intercalated with minims, and respectively, players change between closed and open postures (Fig. 7). Similar postural changes are reported in clarinetists [35].

On the other hand, the swaying motion represents a general indicator of the body's movement and staticity, and functions as conducting element between postures themselves. Inferences about the sway were not clear and need deeper research: in some points, it was identified as rhythmical-related (sway cycles coincided with rhythmical motifs, sway direction was changed according to the pulse), others as structure-related (sway cycles' duration coincided with phrasing – similarly to what's reported in trombonists [26]), but others it happened organically, with no correspondence to musical features. Still, it is possible that general aspects of the sway may convey information about the excerpt being played: slow movements and melodic sections impelled greater amplitude and continuity of the sway, while faster movements and technical sections demanded its reduction or interruption, and therefore less continuity. Also, when the sway was not interrupted, its velocity showed to be related to the pulse of the music. This result adds to the discussion that swaying motion may function as a shaping movement, a global indicator of the performer's movement that operates in the broad layer of the movement hierarchy, whereas localized gestures operate in the detailed layer [25, 27, 40, 46].

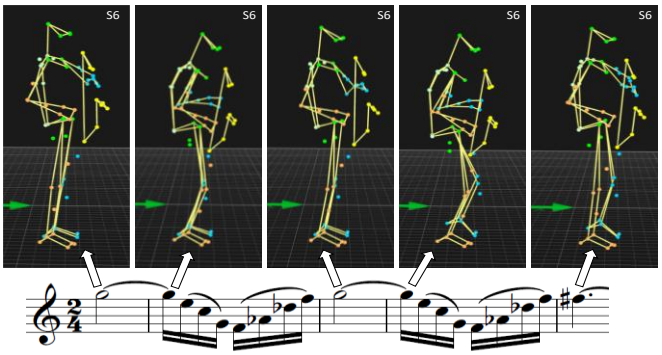

Fig. 7. Bar-by-bar sequence of movement of Subject 9. Semiquaver passages incite closed posture (knee and trunk flexion), and resolutive notes incite body extension and bell lift. Excerpt retrieved from bars 108-112 of Ibert's Concertino da Camera [43].

4 Conclusions

The purpose of this study was to extract a set of recurrent gestural trends based on the systematic analysis of the bodily behavior of saxophonists, related to expression and communication of musical parameters. Specifically, we addressed the relevance of this topic for instrumental education, a field where embodied pedagogies are yet underexplored. The results of this study add to the corpus of research underlining the

importance of the body as intrinsic part of musical experience [1-2, 6] and how music-driven intentions are extrapolated to the performer's motility, embodying structural and expressive layers of musical works [1, 26, 45, 48]. We found that the body language of the performers was transversal across contrasting excerpts and that the relationship between music and movement was better defined by musical parameters such as dynamics, articulation, rhythm, or phrase direction, pointing at the existence of a gesture vocabulary of classical saxophone playing, independent of stylistic features and much more driven by musical syntax. Although the technical and postural demands of the instrument remain the same, we hypothesize variations of this vocabulary may appear in extremely distinct musical genres, such as jazz or popular music.

Revisiting the research questions initially presented, it was possible to produce a description of the most recurrent movement patterns saxophone players execute when performing different excerpts, despite idiosyncrasies related to individual interpretation. It was noted that certain musical contexts elicit gestural trends among distinct instrumentalists: 1) significant expressive locations were emphasized through gestures (for example, bell lifts or flaps), 2) pitch contour motivated accordant body flexion/extension, 3) tempo influenced velocity of the sway and rhythmical gestures were used as aid to timing and subdivision, 4) technically challenging aspects of the pieces incited movement facilitation strategies, and 5) the dichotomy of postures (open versus closed) and swaying cycles constitute general indicators of movement in relation to the music. Although functions of ancillary gestures were separated into expressive and facilitative, we now reflect whether by communicating certain musical features (e.g., by nodding in accentuated notes), musicians are not unconsciously helping their sonic production. In this sense, expressive embodiment may be in itself an adaptative behavior, functioning as a loop between the performer's inner perception, execution, and outer expression. Further research is needed to understand the functional overlapping of music-making gestures, as well as which gestures are beneficial, neutral or prejudicial to performance.

The integration of 3D motion data in the methodology of qualitative systematic observation, in contrast with other studies based only on video footage [44-47], was advantageous to reach precision in the visualization of movement across planes, trajectory drawing, and production of illustrative images. Although in this phase motion data was used to characterize musicians' bodily behavior and provide an overview of most recurrent trends, it will further be the object of quantitative kinematic analysis. Indeed, considering the subjectiveness inherent to this kind of observational studies is often identified as a limitation, next steps of the research will target the selection of a reduced set of gestures for kinematic analysis.

5 Contributions to Embodied Performance Pedagogies

One of the main concerns of instrumental education is the construction of skilled, meaningful performances. These highly rely on developing and refining corporeal apprenticeship presented by the teacher (postures, gestures, positions), to an extent where the student becomes able to embody and control his/her actions autonomously, consequently creating his/her own artistic identity [6, 18]. We believe this study provides

knowledge towards the creation of innovative approaches to the teaching of movement and expression not only in saxophone class, but also in other instrumental contexts. We purpose a concept of embodied pedagogy which addresses body motion not only as a means of producing sound effectively, but also as a means of understanding and enacting Music through instrumental practice.

In accordance with general music education theories [12-17], core concepts of musical theory may be better perceived when associated with movement, and our study provides ideas applicable to expand these practices to instrumental class. For example, we found that saxophone players tend to flex and extend knees and/or trunk in parallel with interval changes and melodic lines, or use certain gestures to mark strong beats or groupings of notes with equal duration. It makes sense that the first example potentiates tuning and the second rhythmic precision, but such assumptions are impossible to infer based on this study. Still, we claim that, instead of addressing concepts of melody or rhythm by theoretical explanation or evocation of physical-related metaphors [18], teachers implement movement exercises that embody those concepts, and can be done with or without instrument playing, depending on the learning level of the student.

Communicative skills are also an essential part of performing to an audience. By identifying musical locations where the majority, when not all, of the professional saxophonists moved in more exposed ways, and connecting them to expressive climaxes, abrupt dynamic changes and resolution notes, we have information on where performers direct their interpretative intentions inside these excerpts. Bell and left-arm gestures, full-body extension and trunk rotation where the most recurrent movements identified in these contexts. Considering how influential bodily movement is in audience perception and evaluation [28-29], musicians and higher-level music students may be able to consciously work their gestures to enhance observers' comprehension of the musical work, by emphasizing significant features. Additionally, illustrative 3D animations of expressive movement possibilities per musical context may be extracted from this database, from which students may create other interpretative choices and communicative styles.

We encourage additional research to validate the saxophone gestural vocabulary, comprising wider samples of players and excerpts, as well as to implement these gestural trends and evaluate their effect on performance optimization and audience perception. This kind of studies contribute to creating science-based foundations for embodied pedagogy programs including deliberate training of expressive, communicative, and facilitative movement skills for music students and professionals, eventually translating into more meaningful performances and greater audience engagement.

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