The informed performer : towards a bio-culturally informed performers' practice

Vanmaele, J.

PART IV: Bio-culturally informed performership in action – two case-studies from the piano-studio

In the preceding PARTS, a conceptual, contextual and practical framework for an informed performership has been proposed and, following the deliberations and considerations in each of these domains, the case has been made for a *Bio-Culturally informed Performers' Practice* [BCiPP]. BCiPP aims at actively exploring information from extra-disciplinary fields (science, humanities, para-academic inquiry), assessing its potential impact on personal and practice theories, and at stimulating trans-disciplinary and bio-cultural dialogue on topical attractors. From this perspective, informational units that live an isolated and fragmented life in *academia* are amenable to re-contextualisation within a practical agenda and to finding a destination in the field of pedagogical reproduction.[366]

In PART IV, two operational examples are presented which provide indications on how such a transformation of information into practice-relevant instruments and insights is achieved. The two case-studies are not in-depth enquiries – this would require a fully separate study; they are presented from the perspective of an informed performer, not the one of an Artistic Information Researcher (see Chapter 8). Their function is to illustrate how the foregoing meta-practical considerations can work in concrete circumstances and in relation to practical challenges and problems.

The first case-study pertains to the attractor-field of *action* and examines how practical insights about the basic stroke(s) in piano-playing can be informed by a selected cluster of Information Units [IUs]; in the final chapter, the domain of *interaction* is explored by creating a tool for performative analysis in terms of embodied vitality.

In accordance with the learning model developed in Chapter 9, in each study the practice situation will first be briefly sketched, followed by presenting relevant IUs from the bio-cultural galaxy of information which are then re-contextualised and developed into a pragmatic and reproductive tool (see Fig. IV.1 for an overview of the modus operandi in PART IV).

[366] The terms 'reproduction' and 'recontextualisation' are borrowed from Basil Bernstein who distinguishes between a field of production where new knowledge is constructed, a field of reproduction where pedagogic practice in schools occurs, and a field in between, called the recontextualising field which is concerned with appropriating discourses from the field of production and transforming them into pedagogic discourse. According to Bernstein, recontextualisation entails de-location or the selective appropriation of a discourse or part of a discourse from the field of production, and relocation in which the original discourse undergoes a transformation according to the play of interests in the contextualising field (Bernstein, 1996, pp. 113–114).

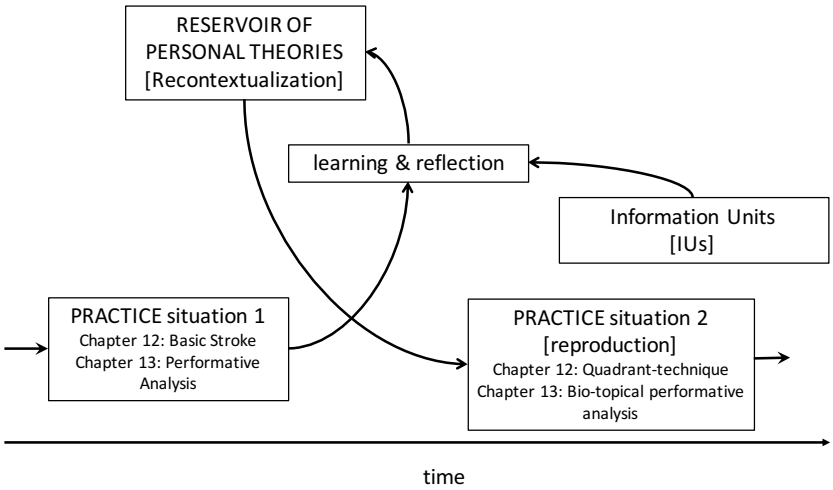

Figure IV.1. Overview of the modus operandi in BCiPP in terms of Bernstein's pedagogic device (Bernstein, 1996).

Chapter 12: The basic stroke(s) in piano playing

The basic stroke in piano playing is an elementary factor in the development of a pianist's repertoire of instrument-directed and sound-producing movements; it logically involves: 1/ a moment of rest or stand-by; 2/ a phase in which the instrument is approached; 3/ a sound-generating key-stroke; and 4/ a moment of release[367]. Different schools of piano playing formulate (implicitly or explicitly) an answer to the question of how to generate the sound of a single and sustained note on a piano in an effective way. Akin to e.g. the forehand stroke in tennis, the basic stroke in piano playing is mainly a didactical tool introduced in the first piano-lessons, to create awareness in terms of muscle-coordination in the arm and hand, and remains an element of development and perfection even in the careers of top-players. The focus of attention among pianists addressing the issue will generally be on the position and involvement of the fingers, knuckles, wrist, elbow and shoulder, and on the use of muscle-power and/or gravitational forces. Most likely, the confrontation of ideas will give rise to a pre-Socratic, unresolved debate, ruled by idiosyncratic opinions, cherished beliefs, personal judgements, and powerful traditions. Notwithstanding these variances, there may still arise a zone of convergence around some basic principles of instrument-directed tone-production which would be seen in most generic piano method books to require:

- A balanced and supportive upper body
- Relaxed shoulders (certainly no elevation)
- Horizontal alignment from elbow, over the wrist to the knuckles[368]
- Freedom in the wrist
- Curved shape of the fingers[369]

More detailed, extended and systematic accounts of single tone production as well as proposals regarding the supporting instrument-directed movements can be found in dedicated SIPP-publications (see 2.2) and their offspring (Bernstein, 1991; Fink, 1992; Brouwer, 2006). However, and as already indicated in Chapter 2, these references are hardly representative for the practical knowledge that

[367] Piano pedagogue Barbara Lister-Sink mentions four phases involved in the basic stroke: 1/ easy, efficient lift of the forearm; 2/ free fall of the forearm; 3/ optimal bone alignment and muscle contraction on the moment of impact; and 4/ instantaneous release (Lister-Sink, 1996). Lister-Sink's approach is strongly tied to the weight-school of piano-playing; in order to allow for the inclusion of other approaches, we will hold on to the four phases as mentioned in the main text.

[368] "The wrist should be positioned to form a more or less straight line between the elbow and the knuckles. Holding it too low will interrupt the flow of muscular continuity from the shoulder to the fingertips. Holding it too high brings fingers too close to the surface of the keys, interfering with articulation" (Berman, 2000, p. 30).

[369] "The correct shape of the pianist's hand is the one that is also the physiologically innate one, with naturally curved fingers" (Berman, 2000, p. 29).

pianists hold with regard to technical accomplishment and tone production. Therefore, and with a view to provide a more explicit *Image* of practice-based understandings and personal theories in this area, we briefly revisit the four *Main Stream Performance*-sources that we discussed in Chapter 2 for more systematic indications in the field of piano-technique and the role of the basic stroke therein.

12.1 A reservoir of basic, personal theories

In *The Art of Piano Playing* (1973), Heinrich Neuhaus brings the technical elements F (force), m (mass), v (velocity), and h (height) to the table in approaching the physical possibilities of instrumental technique (Neuhaus, 1973, p. 58) – although he admits to preferring the use of metaphors when speaking of the locomotor system to his pupils (Neuhaus, 1973, p. 93). The overall framework sketched by Neuhaus is one in which two primary functions are attributed to the fingers: they are "independent living mechanisms" (Neuhaus, 1973, p. 93) which are connected to the weight of the whole hand and arm as required from the dynamical context; simultaneously, and in cases where a considerate volume of sound is required, the fingers are transformed from being independently active units to strong supports: "they become pillars, or rather arches under the dome of the hand, a dome which in principle can bear the full weight of our body" (Neuhaus, 1973, p. 94). From this double use of fingers, Neuhaus infers eight essential elements of piano technique:

1. The playing of one note[370] – the basic stroke or "the amoeba of the piano-playing kingdom" (Neuhaus, 1973, p. 115);
2. Playing two, three, four or five notes;
3. Scales (position-switch of the hand);
4. Arpeggio (broken chord);
5. Double notes (two notes simultaneously);
6. Chords (more than two notes simultaneously);
7. Jumps and leaps;
8. Polyphony.

In *On Piano Playing* (1981), György Sándor promotes the idea that piano playing is not so much a matter of muscular strength and endurance but of proper activation of a complex set of muscles of which some are small and weak, made for precision work, and others are strong and powerful: "we must learn the kind of coordination that enables us to put to use the necessary equipment and to play

[370] "On the piano it is possible to play a single note in so many different ways that this in itself is already an interesting technical problem" (Neuhaus, 1973, p. 115).

without any trace of fatigue, no matter how demanding and difficult the passages we must perform" (Sándor, 1981, pp. 16–17). Next to coordinated muscular energy, Sándor attaches great value to the force of gravity and maintains that muscular and gravitational force in all their combinations account for all the sources of energy available to activate the entire playing equipment. Within his focus on coordination, Sándor assumes an interactive distributive continuum of energies: "total relaxation is non-existent in piano playing. Even when we rely purely on the force of gravity, we must use the necessary muscular equipment to lift and place the arm and hand in their proper positions" (Sándor, 1981, p. 7).[371]

Taking these generic points of view as a point of departure, Sándor subsequently postulates five basic-strokes: 1/ a single note stroke via free fall; 2/ five-fingers, scales, and arpeggios; 3/ rotation; 4/ staccato (octaves); and 5/ thrust. According to Sándor, "these fundamental patterns offer a solution for most, if not all, technical problems in piano playing when they are applied individually or in combination with one another" (Sándor, 1981, p. 115). Sándor claims that these basic technical patterns are recognizable from the indications within the written score but that they are also determined by a performer's individual anatomy, reflexes, temperament, tactile sensibilities, weight and size, and thus allowing for an unlimited variety of shadings, gradations and combinations.

Boris Berman advocates in *Notes from the Pianist's Bench* (2000) a technique that combines well-articulated action by the fingers with the flexibility and fluidity provided for by the wrist. The role of the bigger joints is to give body to the sound and providing brief moments of relaxation by substituting effort with weight (Berman, 2000, p. 25). This leads Berman to formulate two basic principles of piano technique:

> The "economy principle" requires the pianist to be economical in his movements, not to use a bigger part of his body – finger, hand, forearm, arm – when a smaller one will suffice; the "extension principle" requires us to regard each of the various segments of our piano-playing anatomy (finger, hand, forearm, arm) as the continuation of the adjacent parts, with each individual unit always ready to support and share the work with the others. (Berman, 2000, p. 28)

Berman further distinguishes between three fundamental physical actions in piano playing: 1/ the independent use of well-articulated fingers; 2/ rotation movements of wrist or forearm, as well as thrust initiated by these body parts; and 3/ using the weight of the forearm and upper arm as the source of the pianist's physical activity (Berman, 2000, pp. 24–25).

[371] See also Sándor (1981, p. 115).

Finally, Alan Fraser's *The Craft of Piano Playing* (2003) focusses on stabilizing and activating hand structure allowing for the freeing of the wrist and all of the more central parts of the mechanism (lower arm, upper arm, shoulder, spine, pelvis) to accommodate and follow the movement of the hand in a supportive way (Fraser, 2003, p. 26). According to Fraser, functional hand structure is obtained by skeletal alignment (Fraser, 2003, p. 20) and optimization of the intrinsic hand musculature[372]. In the second edition of *The Craft of Piano Playing* (Fraser, 2011) the author is more punctual in this regard and attaches special attention to the (intrinsic) lumbrical muscles[373] and their function in maintaining the hand's arch (Fraser, 2011, pp. 11, 157, 303, 311).

These brief explorations into MSP-references on basic points of view with regard to piano-technique and tone-production add to the zone of convergence the following three elements: 1/ the issue concerning the coordinated trade-off between muscular action and gravitational force via relaxation is at the centre of the debate but varies and is inconclusive in its basic principles, functional details and contributory elements (finger, wrist, arm, shoulder); 2/ there is an urge for reducing instrumental technique to basic components that are then particularised in not one but rather a variety of basic strokes; and 3/ the quest for universality is complemented by a situated approach closely tied to the requirements of a particular score.
From the perspective of BCiPP, the question imposes itself whether and how the process of tone-production in terms of instrument-directed strokes can be further informed by expertise originating from extra-disciplinary fields and how this information can (consiliently) 'jump together' (*con salire*) into a more grounded understanding that allows for further dialogical and accumulative development.

12.2 Bringing extra-disciplinary units of information to the table

As a first step in a process of informing instrument-directed tone production in piano-playing, seven Information Units [IUs] are concisely presented in their original disciplinary context. They are rendered as punctual 'information' – without too much detail and background – and selected from the personal information-base as presented in 11.2.1 (see also Appendix 13). Some of the units are revisited here in a more specific context and with a view to a practical recontextualization in 12.3.

[372] The muscles that move the hand are divided into two groups, the extrinsic and intrinsic muscles. The former are the powerful flexor and extensor muscles of the forearm. These muscles originate outside the hand – the region of the elbow – and insert within the hand. The small muscles are located within the structure of the hand itself and originate and insert within the hand are referred to as intrinsic muscles. These can be further divided into four groups, the thenar, hypothenar, interossei (dorsal and palmar) and lumbrical muscles (Behnke, 2012, pp. 86–93).
[373] The four lumbrical muscles are found deep within the hand and assist with the flexion of the knuckle joints and the extension of the finger joints.

12.2.1 IU 1: skilful action as the coordination of degrees of freedom – neurophysiology

In "some emergent problems of the regulation of motor acts" (1957/1984), Soviet neurophysiologist Nikolai Bernstein (1896-1966) formulates the notion of 'degrees of freedom' as a pivotal element in the realm of motor control.

> The first clear biomechanical distinction between the motor apparatus in man and the higher animals and any artificial self-controlling devices, as I have repeatedly emphasized, lies in the enormous number of degrees of freedom which it can attain, both in respect to the kinematics of the multiple linkages of its freely jointed kinematic chains, and to the elasticity due to the resilience of their connections – the muscles. (Bernstein, 1957/1984, p. 354)

In Bernstein's view, "the co-ordination of a movement is the process of mastering redundant degrees of freedom of the moving organ, in other words its conversion to a controllable system" (Bernstein, 1984, p. 355). Within the context of coordination, Bernstein is one of the first to understand movement as a closed circle of feedback-interaction between the nervous system and the sensory environment and by that he anticipates what is now generally known as *neuro- or brain-plasticity*. Bernstein's notion of coordination as gradually mastering redundant degrees of freedom is still very influential in current research. In a 2009 article in *Neuroscience* medical scientist and pianist Shinichi Fuyura and colleagues take Bernstein's seminal insights as a point of departure to document the results of an experimental set-up designed to measure a skill-level-dependent interaction between gravity and muscular force when striking piano keys[374]; they conclude that "a balance shift from muscular force dependency to gravity dependency for the generation of a target joint torque occurs with long-term piano training" (Furuya, Osu, & Kinoshita, 2009, p. 822).

12.2.2 IU 2: the role of lumbrical muscles – systematic musicology

In an article on the temporal control and hand movement efficiency in skilled music performance (Goebl & Palmer, 2013), musicologists Werner Goebl and Caroline Palmer document the finger movements of highly skilled pianists as they perform a five-finger melody at successively faster tempi.[375] From the analysis, they conclude that the metacarpophalangeal joints (knuckles) contribute most to the downward fingertip motion while the proximal and distal interphalangeal joints (the two finger joints) slightly extend. This latter observation is an element that relates to SIPP-author Ortmann's distinction between a flat- and a curved-finger stroke (1929, pp. 217–250). According to

[374] The study included seven active, award winning expert pianists (three males and four females) with more than 15 years of classical piano training by different instructors, and seven novice piano players (three males and four females) with less than 1 year of piano training (Furuya, Osu, & Kinoshita, 2009, p. 823).

[375] They did so by tracking the movements of finger joints, the hand and the forearm of twelve pianists via a three-dimensional motion-capture system.

Ortmann, the flat-finger stroke features a straight finger that is moved exclusively by the knuckle, while the other finger joints remain immobile; it enables fast finger speeds but lower forces according to the lever principle. The curved-finger stroke features flexed finger joints and allows for more forceful playing. Goebl and Palmer link pianists' finger movement patterns in fast five-finger melodies to a predominant use of the lumbrical (intrinsical) muscles of the hand rather than an extensive use of extrinsic finger muscles. Because of their anatomical trajectory, contraction of the four lumbricals makes the knuckle-joint bend/flex while slightly extending/flattening the fingers (see Fig. 12.1). The authors suggest that "to achieve sufficient finger independence, pianists may avoid extensive use of the extrinsic muscles that are known to exhibit strong biomechanical coupling by generating movements from the lumbrical muscles that are known to be fairly independent", though they immediately add: "more research is necessary to conclusively determine the use of intrinsic and extrinsic muscles in piano performance" (Goebl & Palmer, 2013, pp. 9–10). Fig. 12.1 indicates the difference (from a theoretical perspective) between knuckle-flexion via the *Lumbricals* (left column) and knuckle-flexion via the extrinsic hand musculature (right column).

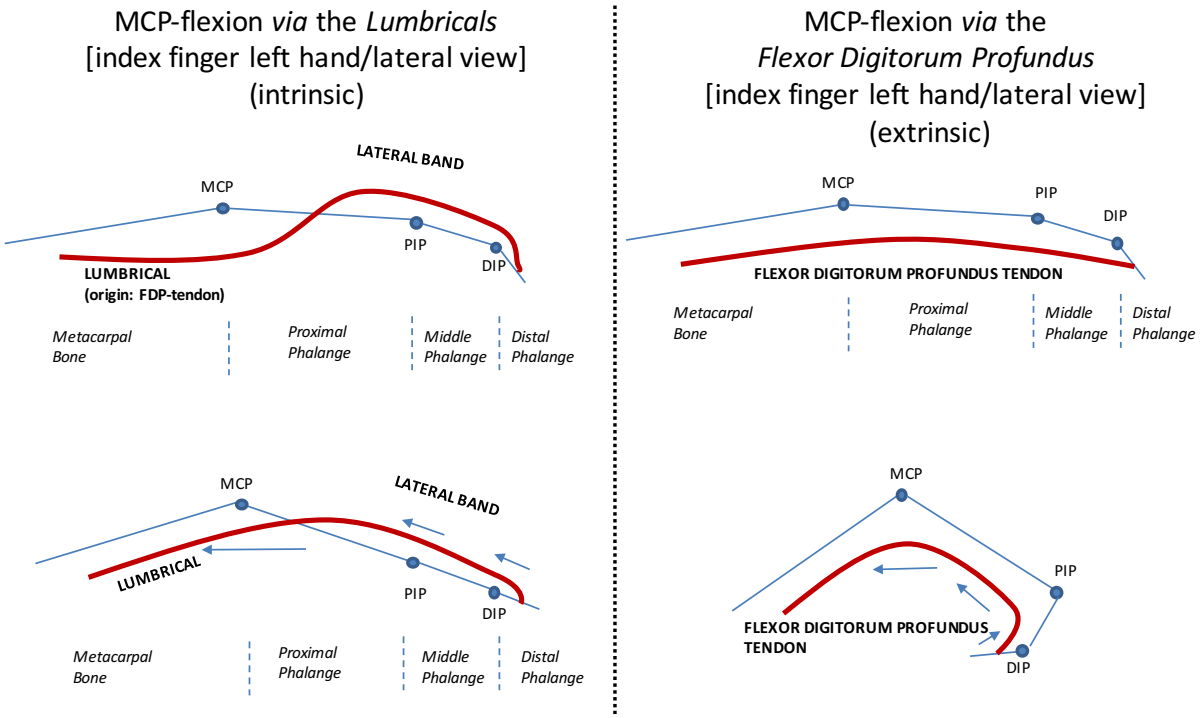

Figure 12.1. MCP-flexion via the lumbricals (left column) or the flexors extrinsic to the hand (right column).[376]

[376] The *Lumbricals* show variable origins and insertions (Lawton, 2013); what is considered to be the most common situation is represented in 12.1. A special thanks to Walter Heynderickx (MD) and Carsten Schoellner (MD) for verifying these anatomical renderings produced by the author.

12.2.3 IU 3: dorsiflexion of the hand[377] – ergonomics/biomechanics

In his doctoral dissertation, music educator Gustavo Daniel Cardinal seeks cooperation with the Indiana University Ergonomics Laboratory to analyse wrist flexion and extension in piano performance (Cardinal, 2010). By means of computer analysis of motion (digitally tracked markers placed on the hand and forearm), Cardinal obtains quantitative data of wrist flexion and extension of the right-hand performance in six short musical tasks. The participants in this study are 32 college-level pianists with no concurrent performance-related medical problems and selected to form four different groups according to gender and hand span. The following elements can be induced:

- The measurement of wrist angle in rest position exhibits degrees of dorsiflexion ranging from approximately 2° to 15° (main knuckles higher than the forearm).
- The curvature of the hand in this position evidences a wide variety of arrangements with no particular hand shape patterns (Cardinal, 2010, p. 215).
- The motion analysis indicates that wrist flexion/extension motion varies with the musical task performed.
- Except for large hand stretches (e.g., octaves), all other tasks (e.g., passage work, a scale, trills, trill-like figures) are performed mostly in degrees of dorsiflexion (a relatively 'low wrist').
- Wrist motions are also influenced by the pianist's gender. In general, males play with a somewhat higher wrist than females, although this is not the case for the octave and chord tasks.[378] As intervals require more hand stretch, higher wrist positions are observed.

Following the results of the experiments, Cardinal advocates a reformulation of the function of the wrist:

> The prescriptive literature on piano technique conceptualizes the function of the wrist mostly as a connective structure that transmits weight and movement. This role is important for piano playing. However, the most fundamental role of the wrist is balancing the length-tension relationship of the flexor and extensor muscles. Acknowledging this important function implies that the motion of the fingers is directly affected by the position of the wrist, and that the use of the wrist (particularly F/E), cannot be representatively described in general terms (as often observed in piano pedagogy, e.g., 'the wrist should be flexible'). (Cardinal, 2010, p. 219)

Cardinal further contends that a flat or elevated wrist may not be the most efficient position for musical tasks and that the level of dorsiflexion found in the position of rest could be considered a better model position than that displaying a flat or elevated wrist.

[377] With dorsiflexion is meant the backward bending of the hand resulting in a 'low' wrist.

[378] Cardinal refers here to research that indicates that females and males negotiate differently between fine motor skills and larger hand/arm movements. Archaeologists Geoff Sanders and Marta Perez could indeed conclude from experiments that "women performed better when movement was restricted to the distal muscles of the wrist and fingers (hand task) while men were better when using the proximal muscles of the upper arm and shoulder (arm task)" and they relate these findings to the hunter-gatherer hypothesis suggesting that gender differences in task performance have arisen through a process of natural selection that favoured the development of brain and body structures supporting the cognitive and motor skills required for hunting in men and for gathering in women (Sanders & Perez, 2007).

12.2.4 IU 4: Chopin as teacher – historical musicology

In the musicological study[379] *Chopin: Pianist and Teacher* (2004), Jean-Jacques Eigeldinger approaches Frédéric Chopin's pianistic and stylistic practices by collecting and analysing a variety of information sources such as Chopin's memoranda, correspondence, the fragmentary versions for a *Sketch for a Method* [*Projet de methode*], the annotated scores of pupils and associates, and the statements of Chopin's own students in diaries, letters and reminiscences. Chopin's interest in *Bel canto* as a model for pianistic declamation and fullness of tone is of interest because of its close link with an element of piano technique and tone production: the use of the wrist.

> True to his principle of imitating great singers in one's playing, Chopin drew from the instrument the secret of how to express breathing. At every point where a singer would take a breath the accomplished pianist […] should take care to raise the wrist so as to let it fall again on the singing note with the greatest suppleness imaginable. (Eigeldinger, 2004, p. 45)

Chopin considers the wrist as the equivalent of respiration in the voice and in annotated scores of Chopin students, strokes across the staff are found which appear to have been marked with the score on the music stand. These strokes indicate breaks of various kinds depending on the musical context. Sometimes it means lifting the hand before a change of pattern or a new motive (Eigeldinger, 2004, p. 112).

12.2.5 IU 5: a two-stage model for the acquisition of voluntary action control – psychology of action

The coupling of action and effect already surfaced in discussing the relations between the components in the topical attractor model (Chapter 11). In a 2001 article in the *Journal of Experimental Psychology: Human Perception and Performance*, experimental psychologists Birgit Elsner and Bernhard Hommel propose and experimentally support a two-stage model for the acquisition of motor control based on the ideomotor[380] principle of action-effect coupling (Elsner & Hommel, 2001).

Stage 1 of this model is concerned with the acquisition of contingencies between movements and effects. As an illustration, Elsner & Hommel present the case of a new-born infant confronted with a

[379] Although Frédéric Chopin (1810-1849) is assumed to pertain to the intra-practical sphere of information, musicologist Jean-Jacques Eigeldinger indicates in his study on the pedagogical insights of Chopin the specific contribution that musicology can make to the field of performance: "The authentically minded interpreter who wishes to do justice to master-pieces of the past faces a multitude of complex problems. Musicology, established now for a century as a positive science, has seen its objectives broaden and diversify. Performance practice, without being altogether a new sphere, is now a field in which musicology is proving itself to the greatest effect" (Eigeldinger, 2004, p. 1).

[380] In psychology, ideomotor theory refers to a framework for action planning which suggests that actions are represented by their perceivable effects. Thus, any activation of the effect image, externally or internally, will trigger the corresponding action.

world full of action opportunities and unable to perform voluntary actions since it has no knowledge of their effects. To acquire this element, new-borns first generate a random motor pattern that leads to a specific, perceivable change in the relationship between the infant and its environment. This change leads to a pattern of activation in the cognitive system (in terms of perception) that, given the temporal overlap of the activation of the motor and the sensory pattern, results in the integration of the corresponding codes. The learning in Stage 1 is automatic and implies that activating one pattern on a later occasion will lead to activating the other one as well.

Stage 2 of the model connects to the selection of goal-directed actions and the recruitment of appropriate movements that are functional in reaching the goal. According to Elsner and Hommel, movements are recruited by activating the perceptual codes that represent the desired goal:

> Given that past co-occurrences of movements and their consequences have led to associations between the underlying motor patterns and the codes of their perceivable effects activating such an effect code will tend to activate its associated motor pattern to a certain degree. This activation allows the effect-oriented selection of motor patterns. Although this selection may be controlled by additional intentional processes, the spreading of activation from the effect to the response codes happens automatically, that is, independent of the agent's intentions. Thus, movements are selected by anticipating (i.e., activating the codes of) their consequences. (Elsner & Hommel, 2001, p. 238)

The authors maintain that the two-stage model has implications that go beyond the first few months in life. In a follow-up article (Elsner et al., 2002) specific reference is made to playing a musical instrument and the differential role of ideomotor and sensorimotor learning in the process. By sensorimotor mapping, people learn associations between cueing stimuli and subsequent actions, whereas by ideomotor learning, associations are acquired between actions and subsequent sensory events: “when playing the piano, both types of learning may be present, but sensorimotor mapping would associate the finger movement to the sight of the note, whereas ideomotor learning would associate the finger movement to the hearing of the tone” (Elsner et al., 2002, p. 364).

12.2.6 IU 6: studies in approach-avoidance behaviour – social psychology

In Chapter 11 (11.2.2.1) we already reported on an article in the *Journal of Personality and Social Psychology* where social psychologists Ronald Friedman and Jens Förster conclude that arm flexion facilitates insight-related creative processes and that arm extension facilitates analytical reasoning (Friedman & Förster, 2000). The experimental tasks that they administer measure the three central elements of creative insight proposed by psychologists Jonathan Schooler and Joseph Melcher (Schooler & Melcher, 1995). The first of these elements involves overcoming fixation on misleading interpretations and strategies rendered overaccessible by the context of the problem. The second element entails breaking away from inappropriate initial assumptions and strategies by re-encoding

components of the problem into a novel global representation. The final element of creative insight according to Schooler and Melcher entails memory search for novel responses and strategies.

Of particular interest in the context of instrument-directed technique is the experimental method that the inquirers employ. To induce either positive or negative hedonic states they rely on non-affective bodily feed-back generated by pressing upward on a table (arm flexor contraction) or pressing downward on a table (arm extensor contraction). This procedure has been introduced by social neuroscientist John T. Cacioppo and colleagues who found supportive evidence to the fact that arm flexion gives rise to bodily feedback associated with approaching positive stimuli, whereas arm extension gives rise to bodily feedback associated with avoiding negative stimuli (Cacioppo, Priester, & Berntson, 1993). This hypothesis is based on the learning-theoretical notion that, over the course of a lifetime, arm flexion (where the motor action is directed toward the self) is repeatedly associated with acquiring or consuming desired objects (i.e. approach motivation), whereas arm extension (where the motor action is directed away from the self) is repeatedly associated with rejecting undesired objects (i.e. avoidance motivation).

12.2.7 IU 7: the sight of sound – psychology

In a 1995 contribution to *Music and the Mind Machine* (Steinberg, 1995), psychologist Jane Davidson reflects on a series of experiments where the *point-light technique*[381] is adopted to asses the visual information contained in music performances (Davidson, 1993). In these studies, the performers are asked to perform the same piece of music in different expressive manners: projected – as in public performance, deadpan and exaggerated. The observers are subsequently presented with these manners in three modes: the visual point-light stimuli alone, the sound alone, and the combined visual and sound stimuli. From the results, it can be inferred that there is sufficient perceptual information contained in visual information of kinematics alone to permit the identification of performance manners. Furthermore, vision seems to be the only mode to significantly differentiate between projected and exaggerated manners, suggesting that vision most strongly conveys the differences between the three performance manners. From an ensuing exploratory investigation Davidson infers the suggestion that "for the non-musician, visual stimulus mode may be the main source of information about the expressive intention of the performer" (Davidson, 1995, p. 110).

[381] In the point-light procedure, test-persons are dressed in black clothing with reflective tape attached to their major joints; they are consequently videotaped while a spotlight shines on them. After recording the movement, on-screen adjustments are made so that only the moving dots against a black background are visible, thus isolating pure movement (Johansson, 1973).

12.3 Recontextualisation of IUs in piano technique

The seven IUs presented above originate from a variety of disciplinary fields and generally do not cross-refer to each other. They constitute pieces of information, freestanding elements of a jigsaw-puzzle, of which some do and other do not imply an immediate link with playing a musical instrument. From the perspective of BCiPP, the question arises how these elements of information can be interrelated ('jump together') and how they can have an impact[382] on the reservoir of personal theories that are present in the practice of piano-playing.

IU1 – Bernstein's notion of coordinating degrees of freedom and the gradual and experience-related shift from using muscular force to depending on gravitational force – seems to be of a confirmational type, especially with regard to the skill-dependent trade-off between muscle force and gravity which is a prominent topic in MSP-texts. However, by employing a scientific apparatus (statistics, measurements, representative sample of participants) the study goes beyond personal experience (see Section 3.3: the third form of life of information) and adds extra authority to a principle of piano-technique that has already been suggested in several practical and experience-based contexts. Since there is no absolute agreement on the matter among pianists, this IU could easily be used to overthrow or marginalise deviating perspectives in a process of deterministic scientification and simplification (see Chapter 6). A conclusion that Nikolai Bernstein and mathematician Tatyana Popova drew in the 1930s from their seminal experiments related to rhythmic octave strike on the piano[383] is illustrative of such an eliminative influence based on scientific experiments. It indicates that such information must be handled cautiously and that a contextualisation of the facts into a broader context of practical *Images* is a *conditio sine qua non*. In their article, they develop the following logical induction:

> During slow and medium tempi, both the hand and the forearm move under the action of their own active muscle impulses. At medium tempi, a sequence of such impulses merges into a single continuous chain, while during slow tempi, individual impulses leading to strikes are separated by more or less prolonged periods of inactivity. […] Since the mechanism of fast piano playing movements differs so dramatically and deeply from the mechanism of slow movements, it becomes very clear that studying complex passages at slow tempi, or drilling difficult parts, is unjustified. (Bernstein & Popova, 1930; reprinted in Kay, Turvey, & Meijer, 2003, p. 38)

From a scientific perspective, Bernstein and Popova's conclusion about the absurdity of practicing slowly has meanwhile been technically countered by insights such as Adam's closed-loop model (see 11.2.2.1); there it is asserted that learning by error detection and correction is only possibly in slow

[382] See 4.3.2.3 on information use (e.g. enlightenment, problem understanding, instrumental, factual, confirmational, projective, motivational) (Taylor, 1991, p. 230).
[383] They did so by using a new device for movement recording, a kymocyclograph.

movements and by means of many repetitions which eventually transform closed-loop processes into a quasi-automatic open-loop process. Also from a pragmatic perspective, practising slowly has been found to be helpful in a context on increasing and perfecting audio-motor integration (Kutik, 2016), an aspect which Bernstein, who focuses on movement alone, does not seem to take into account. Furuya's experiment-based observations with regard to the relation between level of expertise and the use of gravity implies a higher standard of ecological validity but also here questions arise. For instance, studying seven "award winning expert pianists" may well be a sample that holds enough representative guaranties for an exploratory scientific experiment, but the dedicated practitioner will need more detail and visual and auditory reference to assess the value of the research-outcome in relation to her/his *Image*.

How then can IU1 be qualified in terms of information impact? The main contribution of Bernstein's stipulation of skilled movement as a coordination of degrees of freedom to musicians is that it offers a new vocabulary (freedom and coordination as potential boundary topics) and a systematic and principled perspective on a developmental and physical aspect of performance: defining technique in terms of freedom and coordination, and adding to that a trajectory in which muscular force gives way to gravitational force opens a dialogical field where a variety of perspectives can meet and where agenda's can be set for further enquiry and assessment.

A similar agenda-setting-role can be attributed to IU2. The function of the intrinsic hand musculature in piano playing has only just entered the concerns of pianists (Fraser, 2011) and also recent studies in biomechanics and anatomy confirm a (temporary) state of inconclusiveness about their functional roles: "the unique properties of the *Lumbricals* indicate that they are probably [own emphasis] important in fast, alternating movements, such as typing and playing instruments" (Palti & Vigler, 2012, p. 15). The situated differentiation between flat and bent fingers and the use of intrinsic and extrinsic hand musculature impacts on a central element from the zone of convergence, the one that recommends curved fingers as a standard position. Making a reference to Ortmann's research is likely to instil some confidence in the tentative conclusions by Goebl & Palmer but being in a state of vagueness, the matter would certainly benefit from future collaborative research and discussion before it can really impact on the minds and hands of pianists. On the agenda with regard to potential contributions of intrinsic hand musculature to piano-playing, the role of the 5 interosseous muscles in abduction (spreading of the fingers) and adduction is also a terrain to be explored.

The author of IU3 – dorsiflexion of the wrist – sketches the context of his doctoral research by explicitly stating that the inquiry is an evaluative tool to asses often contrasting pedagogical information and practices concerning wrist position and motion (Cardinal, 2010, p. 221). The impact of the information

may be confrontational to practitioners who consider it a universal law to maintain a horizontal alignment from elbow to the knuckles in piano playing. Cardinal's differential analysis in terms of hand span and gender opens a perspective of individual assessment rather than a unifying dogma. By envisaging an extension of the sample-domain in the direction of younger and older participants, the author hopes to extend insights into the role of skeletal and muscular development in wrist extension and flexion (Cardinal, 2010, p. 232), an element that would certainly impact on the didactical implications. What could make this domain of study even more relevant is to investigate aspects such as the potential differentiation between wrist dorsiflexion in the right and left hand, the relation of dorsiflexion to the use of the lumbrical muscles[384] [IU2], and the role of repertoire in wrist position. An example of a pronounced dorsiflexion for instance can be found in Mitsuko Uchida's rendition of Bach's *Sarabande* from the French suite nr. 5 in G major BWV 816 (hhaayyddnn, 2015) whereas this physical disposition seems to be less pronounced in Uchida playing Mozart (Vincenzo V, 2012) or Schumann (Berliner Philharmoniker, 2009). Next to Uchida also another female pianist with extraordinary technical skills, Martha Argerich, often adopt such a pronounced low wrist position. This prompts (research) questions such as: is this a conscious or learned strategy[385]; can the differential use of extrinsic and intrinsic muscles be experimentaly measured?

The indications collected by Eigeldinger on Chopin's piano technique [IU4] present a cultural element in the consilient and dialogical field related to instrument-directed tone production and add to the information cluster the factor repertoire. Raising the wrist as a musical gesture in piano playing is usually connected to 19th century piano music although some pianists will apply it transhistorically. The raising of the wrist, as a consequence of elevating the arm, can be naturally and logically linked to inhaling via chest expansion and slight collar bone and shoulder elevation which cause the arm to lift. Such considerations which link specific instrument-directed movements to elementary bodily activities are only implicitly present in accounts such as Chopin's and are barely traceable in scholarly literature.[386] Also here, a bio-cultural perspective would allow for a deepened understanding and dialogical integration.

Research and scholarship related to ideomotor theories of action-effect coupling [IU5] explicates in a clear way implicit and vague everyday intuitions and experiences and brings them within the structural purview of a limited set of principles through integration and subsumption. By reminding the

[384] The lumbrical muscles are only mentioned in an anatomical overview (Cardinal, 2010, p. 33).
[385] Both pianists studied with Maria Curcio (1918-2009) who advocated a rather low wrist position in her teaching (Ashley, 1993).
[386] Alexandra Pierce's *Deepening Musical Performance through Movement* is a notable exception (Pierce, 2007).

importance of audio-motor integration in approaching technical matters and the role of imagination in action-effect coupling, this IU has didactic implications that reach beyond the basic stroke. The 'silent piano'-technique is illustrative for this wider field of application; it has been developed in the piano-studio against the theoretical background of action-effect coupling and is a didactical tool that aims at conveying elements of microtiming to students by analogue and non-verbal means. In silent-piano sessions, the teacher plays on an acoustic instrument while the student plays on a keyboard or digital instrument in silent mode. While playing, the student does not get the audio-feedback from his own actions but from the sounds produced by the teacher. As would be predicted from an action-effect coupling perspective, students gradually attune their actions to the sound, and when playing on the acoustic instrument afterwards, they have – to a differing extent – acquired the sound image of their teacher especially in terms of instrument-directed action.
By transgressing the borders between imagination, movement and effect, IU5 allows for systemic integration of separate elements of instrumental technique into an embodied whole.

By inversely linking approach-avoidance motivation to muscular states, IU6 adds a new element to the spectrum that has not (yet) found its way into piano-pedagogy and is also absent in music-oriented disciplinary handbooks (Lehmann, 2007; Parncutt & McPherson, 2002). Translating the *modus operandi* used by Friedman and Förster to the situation of pianists leads to the trivial inference that piano-playing could be prone to inducing avoidance behaviour and limited creativity because of the downward force that is inherently exerted on the keyboard. This is a very primitive deduction that should be weighed against other aspects such as the expertise-related trade-off between muscular and gravitational energy from which it could then be inferred that a certain level of expertise does not only impact on coordination but also on the capacity of creative insight (see IU1). IU6 has certainly the potential to extend pianists' perspective of technique but also calls for further differentiation. In the scientific approach for instance, a duality is assumed by the authors between approach and avoidance motivation without providing a 'neutral' middle-ground. In the context of piano playing, the question imposes itself whether either of these two types of archetypical motivation is adequate. Considering it as one of the roles of the performer to embody varied states of mind implied in a composition, should performers not aim for a neutral state, an empty canvas that frees the voluntary motor system from emotional high-jacking (see 11.2.2.c)?

Finally, the linkage between vision and sound [IU7] allows via the notion of gesture for a link between the topical domains of 'action' and 'interaction'. In IU4, a relation between a wrist-gesture and breathing was suggested in Chopin-repertoire, but the repertory of interactive gestures is certainly ready to be extended. In publications such as pianist Seymour Bernstein's *20 Lessons in Keyboard*

Choreography (Bernstein, 1991) such a link is explicitly forged but also from scientific theories such as the motor theory of speech perception[387] (Liberman & Mattingly, 1985) and from evolutionary accounts of language (Corballis, 2009) valuable inferences can be made. Considering linguistic communication primarily as a gestural system, evolved from the so-called mirror system in the primate brain, resonates well with the framework of communicative musicality (Malloch & Trevarthen, 2009a) and lifts the issue of basic strokes beyond a strictly technical concern to the domain of communication and expression.

IU	*Domain*	Key terms	Impact on piano technique
1	*Neurophysiology*	Three streams (gesture, groove,	Confirmation, new vocabulary, systematic framework, agenda-setting
2	*Systematic musicology*	Intrinsic hand musculature (*Lumbricals*)	New element to be assessed, agenda-setting
3	*Ergonomics Biomechanics*	Wrist extension/flexion – dorsiflexion	Confrontation
4	*Historical musicology*	Chopin's 'breathing' wrist	Particularisation and differentiation in terms of repertoire
5	*Psychology of action*	Action-effect coupling	Systemic integration
6	*Social psychology*	Influence of arm flexion/extension on creative insight	New element in need of differentiation and assessment
7	*Psychology*	Visual perception of sound	Opening the domain of interaction

Figure 12.2. IUs impacting on practical understandings regarding the basic stroke in piano playing.

12.4 Reproduction: the Quadrant-technique

In Fig. 12.2, the various elements presented in Section 12.2 and discussed in Section 12.3 are summarized. A common feature to all IUs in relation to action is that they open a dialogical field which invites further assessment and inquiry in terms of differentiation and interrelation. Transdisciplinary dialogue is one way to proceed in that direction, intra-practical and pragmatic evaluation in the piano-studio is another which does not exclude the former strategy. From the perspective of Basil Bernstein's *pedagogical device*, a reproductive tool can be considered as embodying the state of knowledge with regard to a particular field in such a way that it allows for didactic conveyance, pragmatic refinement, particularisation and potentially also validation.

[387] "The first claim of the motor theory, as revised, is that the objects of speech perception are the intended phonetic gestures of the speaker, represented in the brain as invariant motor commands that call for movements of the articulators through certain linguistically significant configurations" (Liberman & Mattingly, 1985, p. 2).

In this section, such a reproductive tool is presented under the label of the Quadrant-technique.

12.4.1 The Quadrant-technique: basic tenets

The *Quadrant-technique* is a four-stage reproduction model used in coaching pianists and creating instrument-directed upper-limb awareness at various levels of proficiency; the term 'quadrant' refers to the fact that the basic strokes in piano-playing circumscribe a quadrant of the circle that could be drawn if the shoulder would make a full-circle rotation (see Fig. 12.3). The technique is based on four primary foundations: 1/ personal experience; 2/ a reservoir of intra-practical insights (see 12.1); 3/ the extra-disciplinary IUs that we have discussed in 12.2; and 4/ the general context of the topical attractor model presented in Chapter 11 which allows for the situated interconnection of the IUs.
The tool is schematically represented by Fig. 12.3-6 and closes the circle from extra-disciplinary output to intra-disciplinary impact.

Within the context of the Quadrant-technique, phase 1 [Fig. 12.4] is the *zero-position* which is characterized by relaxation of the muscles of the shoulder girdle and upper-limb. In this position pianists can gain awareness on: 1/ the intrinsic shape of the hand (slightly curved fingers); 2/ the slight, naturally induced dorsiflexion of the wrist [IU3]; 3/ the rest-position of radius and ulna (the two bones forming the lower arm); and 4/ the rest-position of the shoulder girdle.
Phase 2 [Fig. 12.5], called the *breathing position* [IU4] is an active phase in which the arm is lifted via a rotational movement in the *gleno-humeral joint*[388]. During the lift-phase the lower arm 'falls' into a pronated position[389] which induces a slight abduction and endo-rotation of the *humerus.* Once the arm has reached its highest position, one should become aware of the anti-gravitational forces developed in the shoulder- and elbow-zone.
Phase 3 [Fig. 12.6] brings the hand in a sound-producing position. The crucial element here is to effectuate an action-effect link between muscular relaxation in the shoulder and sound production. Pianists may relate muscular tension, as an active and intentional component of piano-playing, to sound-production and end up with a playing apparatus that is for the most part based on muscular energy. It is a Copernican turn to realize that the most comfortable position of the hand is not the *breathing position* but the play position where the keyboard supports to a certain extent the weight of the arm and where sound is produced by means of relaxation. In Phase 3 a skeletal alignement is envisaged between the joints of the fingers, the knuckles and the wrist which results in a 'grand arch'

[388] The articulation between the glenoid cavity of the scapula (shoulder blade) and the head of the humerus (upper arm bone).
[389] 'Pronation' is the act of turning the palm downward via rotation of the forearm; 'supination' is the action of turning the hand so that the palm is up.

which connects fingertips to the elbow via the wrist. In the context of instrumental didactics, this position is reffered to as the 'digital position': the *digitus* (fingertip) carries a large portion of the weight (see 12.1 and Neuhaus' notion of the fingers as pillars) and such a playing position is adequate in passages that require the production of a 'big' sound.

In phase 4 [Fig. 12.7], the playing position evolves into a resting position by relaxing the flexors that connect the lower arm to the hand [*flexor carpe radialis* and *ulnaris*]; by relaxing these flexors the wrist is lowered and the weight of the arm is re-distributed from the tip of the finger in the direction of the the carpal bones or the heel of the hand; here, the 'grand arch' transforms into a 'hand arch'. This position is also referred to as the 'carpal position'; because of the redistribution of weight from the *digitus* to the *carpal bones*; this position allows for the fingers to move lightly and freely (see 12.1 and Neuhaus' notion of the fingers as 'independent living mechanisms').

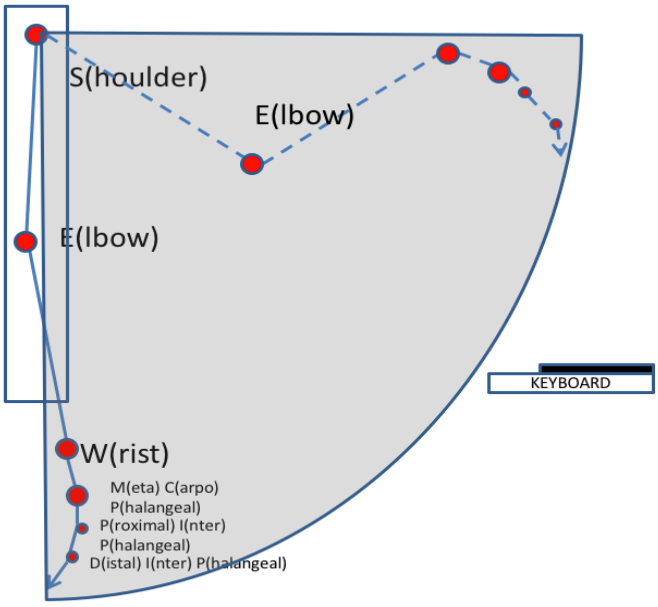

Figure 12.3. The Quadrant of piano-directed movement.

Quadrant-technique: zero-position

- rest position
- relaxation of shoulder muscles/biceps & triceps/pronators & supinator
- naturally curved fingers

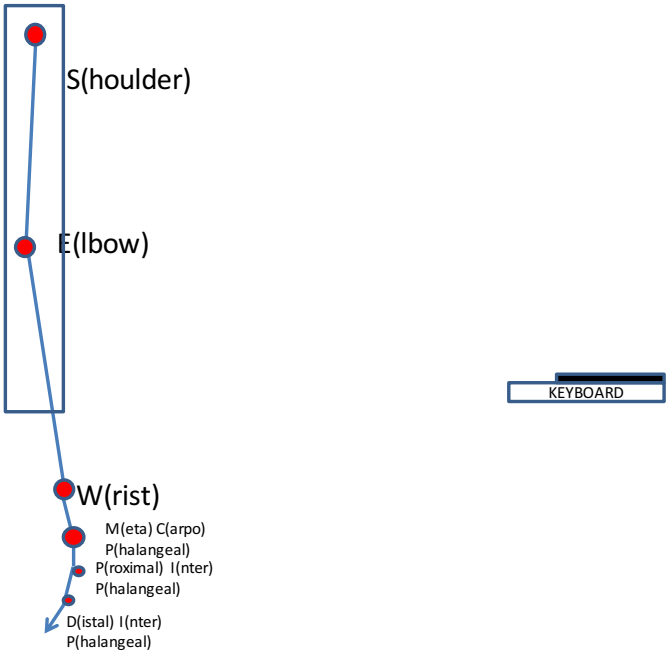

Figure 12.4. Quadrant-technique: zero-position.

Quadrant-technique : breathing position

- suspension-'stiffness' in shoulder and elbow
- gravity-induced pronation
- slight abduction + endorotation shoulder
- relaxation in wrist (extensors & flexors), MCP and fingers
- no support from the keyboard (no contact)

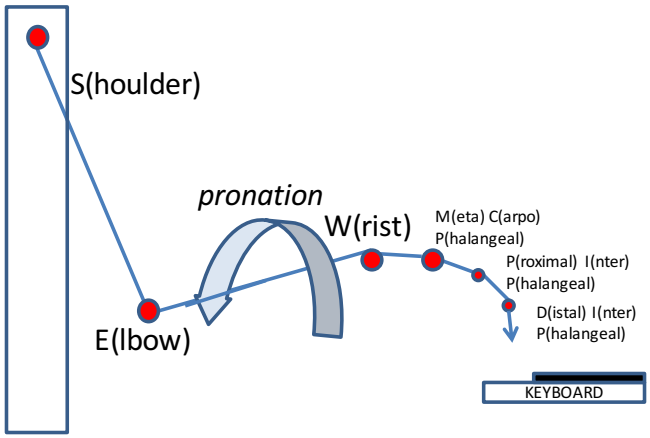

Figure 12.5. Quadrant-technique: breathing position.

Quadrant-technique : play & listening position I

- rotational relaxation of shoulder and elbow (biceps)
- coupling of relaxation with the effect of a sounding instrument
- temporary 'stiffness' in W (grand arch)
- skeletal alignment in MCP/PIP/DIP
- support from the keyboard + lumbrical support in MCP

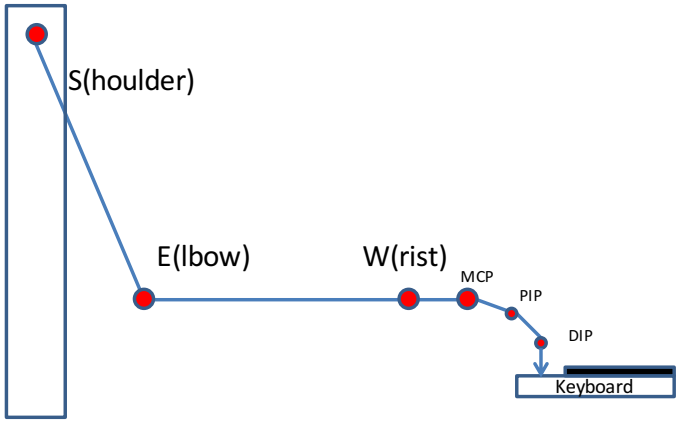

Figure 12.6. Quadrant-technique: play & listening position (also called 'digital position').

Quadrant-technique : rest-position

- relaxed shoulder and elbow (slight abdution + endorotation)
- (semi)-relaxed wrist (flexor carpi radialis/ulnaris)-> re-distributing the gravitational impact -> hand-arch
- support and skeletal alignment in MCP/PIP/DIP
- support from the keyboard

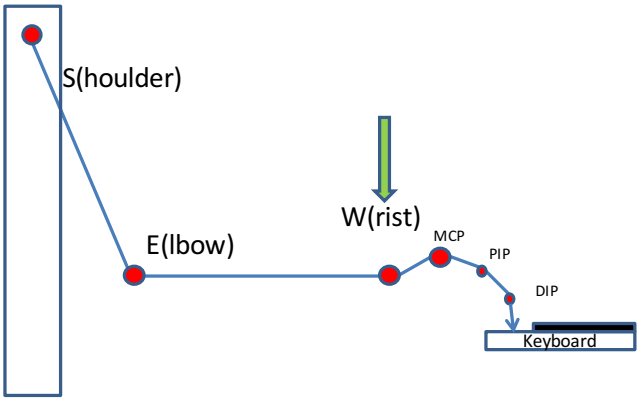

Figure 12.7. Quadrant-technique: rest-position (also called 'carpal position').

12.4.2 Four basic strokes within the quadrant

The four positions described above give rise to a catalogue of four essential or basic strokes: 1/ The first is a down-stroke and follows the sequence of events as illustrated above: it evolves from a zero-, over a breathing- into a play-, listening and rest-position; 2/ the up-stroke moves upwards from a rest-position into the breathing position and embodies staccato-playing; 3/ the third essential stroke involves the playing of two connected notes and combines the down- and up-stroke into a *Seufzer*; and 4/ the fourth essential stroke relates to phrasing more than two notes, it is initiated from the zero-position to evolve in the breathing position where the tension is gently released into a rest-position to softly play the first note of a series of legato-connected notes. By the end of the series the hand is brought back into the breathing position to close the phrase.

Together these four strokes resonate with the practical situations that a pianist encounters in an early stage of study and in combination with a process of deep learning, they allow for basic instrument-directed proficiency and coordination. However, more advanced levels of piano playing would require extensions to this basic framework. A rotational technique *à la* Matthay (Matthay, 1903) where sound is produced or supported either by pronation or supination is one specific add-on, delicate finger-strokes combined with a suspended position of the arm [breathing position] and producing fragile sounds and sound-clouds are another extension. On a more systemetic level, additions to the Quadrant-technique involve primarily a differentiation in pivotal points.

12.4.3 Fulcrum-based extensions of the Quadrant-technique

The four strokes as proposed in 12.4.2 have the gleno-humeral joint (shoulder joint) as their principal fulcrum (pivotal point). This choice is informed by Bernstein's notion of *degrees of freedom* from which it can be inferred that in order to arrive at a functional coordination of these degrees maximal involvement of the joints is mandatory. Taking a fulcrum such as the metacarpophalangeal joint (knuckle) as a primary reference and starting point would allow for the stiffening and immobilization of the other degrees of freedom.

This choice for four shoulder-centred strokes as the primary point of departure in piano-technique invites in a further stage fulcrum-led extension. A down- or an up-stroke can just as well be elbow-, wrist-, knuckle- or even phalangeal-based and the choice for one of these fulcrums is mostly related to the gestural and sound-effect that is adequate in a particular repertoire. Music from the classical period for instance, precedes the Chopin-related idea of a *Bel canto* inspired breathing wrist, therefore, phrasing and sound-production will in most cases be more elegant if the articulation is generated by the wrist, thereby only generating minimal movement in shoulder and elbow. The adequateness of a

wrist-articulation in this case is related to the breathing-volume needed for the phrase as well as to the way in which the dampers reach the strings after key release.

In a 2010 documentary, Barthold Kuijken addresses the central importance of breathing in music performance and states that "one has to learn to inhale what one is about to play, also in the emotion not only in technical terms"[390] (Soetewey & T'Seyen, 2010). Translating this principle to a keyboard reality and taking into account the evolution of phrasing in Western Art Music, one logically arrives at differentiated levels and modes of breathing via the keystroke.

Next to the sheer breathing-volume also the anticipation of sound differs according to the choice of fulcrum: in the case of a shoulder-centred stroke the sound is embedded in a long preparatory trajectory while a wrist-induced stroke is more agile and surprising in its intersubjective effect. This technical and musical differentiation is also evident from the historical evolution of piano-technique which evolved from a harpsichord-related finger-technique to a *Schwung*-technique by the end of the nineteenth century (Kloppenburg, 1951, 1992; Kochevitsky, 1967).

As far as key-release is concerned: when the key is released with a passive wrist, there is an upward movement already before the strings are damped, the gesture prepares and accompanies the actual sound event; releasing the key without wrist anticipation leads to the perception of simultaneity between vision and sound, and to a more punctual phrasing.

12.5 Field of application

A reproductive tool such as the Quadrant-technique offers an embodied and pragmatic point of departure for technical and musical development, assessment, extension, dialogue and critique. While its nature is inherently inconclusive, open ended and flexible, it can be used as a valuable frame of reference in first initiations to the piano. It establishes bodily awareness, in a context of re-education or as a reflective and generative framework in interpretative matters such as phrasing and sound impact. The Quadrant technique presents a systemic frame of reference that facilitates traditional modes of technical exploration; by explicitly providing the bio-cultural information that leads to its configuration, students and colleagues are stimulated to reflect, to adjust and to add a method to deep learning.

The integration of extra-disciplinar information and personal, practical theories into a model such as the Quadrant technique is facilitated by mediation of a systematic information system such as the topical attractor model presented in Chapter 11. The Quadrant technique illustrates that having an information model in the background of personal inquiry does not only allow for the attraction of

[390] "Je moet leren inademen wat je gaat spelen, ook in de emotie, niet alleen maar techniek" (Soetewey & T'Seyen, 2010).

information, it also functions as a first zone of assessment, an area where Information Units can dialogue and spring together with other information or practical experiences.