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The Keyboard as a Part of Visual, Auditory, and Kinesthetic Processing in Sight-Reading at the Piano

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ABSTRACT

Sight-reading at the piano requires coordination of multiple modalities—visual, auditory, and kinesthetic. Visual feedback (obtained by looking at the keyboard and the fingers) is usually regarded as one means by which pianists guide musical performance, but few researchers have focused on the organisational aspects implicit in the information provided by the keyboard. This study investigated the role of the keyboard with respect to the visual, auditory, and kinesthetic modalities involved in sight-reading. Five pianists sight-read two compositions, each in a different musical style. They were then interviewed in a semi-structured interview format. A qualitative content analysis was made from the data. The keyboard proved to play a significant role in sight-reading at the piano: the results indicated that the keyboard was involved in generating visual, auditory, and kinesthetic imageries, as well as motor actions. The pianists also relied on visual feedback in order to execute discrete movements on the keyboard. Visual, auditory, and kinesthetic processing were all dependent on contextual factors identified in the score as well as on whether the composition was tonal or non-tonal. The utilisation of the keyboard, brought on by effective visual input, involved two kinds of sensory dimensions: visual-kinesthetic imagery and (visual-) auditory-kinesthetic imagery. The former led to partly pre-defined motor responses and the latter, to flexible finger movements. On the other hand, visual feedback seemed to be utilised when the pianists were unable to conceptualise the information available in the score.

I. BACKGROUND

Sight-reading has been widely studied (for review, see Lehmann and McArthur 2002). The expert-novice difference in performance has been one area of exploring music reading ability (Sloboda 1976; Goolsby 1994; Banton 1995; Lehmann and Ericsson 1996; Sloboda, Clarke, Parncutt and Raekallio 1998; Waters, Townsend and Underwood 1998). Sight-reading has also been considered to include component skills (or subskills) such as “pattern recognition” skills, “prediction” skills, the ability to generate and use auditory representations (Waters, Townsend and Underwood 1998); improvisation, recall, and kinesthetic ability (Lehmann and Ericsson 1996). In many studies, sight-reading has been characterized as a process of transcription, in which the performer must (rapidly) convert information from one form into another (Waters, Townsend and Underwood 1998; see also Sloboda 1984). The transcription task is supposed to involve (perceptual and cognitive) ‘input’ and (motor) ‘output’ skills (see Waters, Townsend and Underwood 1998). Researchers have also outlined the acquisition of sight-reading skills: sight-reading has been examined in relation to involvement in domain-related activities and accumulation of (accompanying) repertoire (Lehmann and Ericsson 1993, 1996).

Many of the previous studies have concerned visual modality. Since the ability to process notes in a score is essential for sight-reading, many of the earlier studies have focused on issues concerning music reading (for reviews, see Sloboda 1984; Hodges 1992). Most of these studies have been based on the pianistic viewpoint. It has been discovered that skilled sight-readers have a large perceptual span (Goolsby 1994). The results of previous studies have also showed that pattern recognition is an essential part of skilled music reading (Wolf 1976; Waters, Townsend and Underwood 1998). Keyboard musicians are also guided by musical texture: it has been found that errors in sight-reading tend to be contextually appropriate when the musical setting is mostly homophonic; on the other hand, the errors are less relevant in a contrapuntal setting (Gingras, McAdams and Schubert 2007). On the whole, the processing of music notation has been presumed to be dependent on the knowledge of music structure and theory (Sloboda 1984; Lehmann and Ericsson 1996; Waters, Townsend and Underwood 1998; see also Lehmann and McArthur 2002). Especially important within this area are the findings concerning ”proofreader’s error” and “eye-hand span” showing that (skilled) sight-readers are able to encode the structure of the music seen in the score (Sloboda 1976; Sloboda 1977).

The fingering choice made by pianists in sight-reading is one of the aspects concerning kinesthetic (motor) actions. The fingerings are dependent, for example, on cognitive constraints, which include the ability to encode and consider the fingering solutions in respect to the context: the results of the study examining the expertise in piano fingering indicated that expert pianists utilise overlearned, “rule-governed response sequences” (e.g., standard fingerings), which are the consequence of the perception of familiar visual patterns (such as scales and broken chords) within the notation (Sloboda, Clarke, Parncutt and Raekallio 1998).

The keyboard can be regarded as an integral part of musicing regardless of the perspective from which the performance is examined. Only a few previous studies concerning sight-reading have touched on issues concerning the keyboard, yet the viewpoint has been either visual feedback (Banton 1995, Lehmann and Ericsson 1996) or fingerings together with motor-anatomical constraints, and the properties of the keyboard (arrangement of the black and white keys: Sloboda et al. 1998). The aim of the researchers has been to find out the extent to which pianists are looking at their fingers while sight-reading. The results showed that sight-reading performance was disrupted when the visual feedback was prevented (Banton 1995; Lehmann and Ericsson 1996). Visual feedback was thus assumed to be an important part of sight-reading, particularly for inexperienced sight-readers (Banton 1995). Visual feedback has also been examined in connection with motor movements; the ability to execute large

jumps on the keyboard (without visual feedback) proved to correlate stronger with prior experience in the jumps than with (general) sight-reading ability, and was thus not supposed to be a prerequisite for sight-reading (Lehmann and Ericsson 1996). Nonetheless, it has been suggested that "avoiding unnecessary glances at the keyboard will improve performance" (Lehmann and McArthur 2002, 140).

Taken together, the results of previous studies seem to have an emphasis on either (visual) music reading skills or (kinesthetic) motor skills. Although the ability to perform without visual feedback has been found to be important in sight-reading, the foundations on which this ability is based have not been studied. Seldom, therefore, have the implicit aspects of conceiving the information provided by the keyboard been focused on.

II. AIMS

The aim of my article is to examine the role of the keyboard with respect to visual, auditory, and kinesthetic modality, the focus being on visual-kinesthetic aspects. The article is based on my previous study (Ronkainen 2008) which investigated visual, auditory, and kinesthetic modalities involved in sight-reading performance at the piano.

More specifically, the main purpose is to compare sight-reading performances of two compositions, each in a different musical style (tonal and non-tonal). The hypothesis is that the utilisation of the keyboard is dependent on the musical style within the score being sight-read by the pianists. The perspective of the present study is somewhat in contrast to that found in earlier studies; in addition to examining the function of visual feedback, the study is also interested in describing the strategies by which pianists are able to sight-read without looking at the keyboard.

III. METHODS

The study was a qualitative case study. The participants were five professional students from the Department of Piano Music of the Sibelius Academy (Helsinki, Finland). In the experiment, the pianists sight-read two compositions—first the tonal, then the non-tonal (the tonal composition and the middle page of the non-tonal composition are included; see appendixes 1 and 2)—after which they were interviewed in a semi-structured theme interview format. Additionally, both the performance and the interview were recorded as MIDI data and video taped. A qualitative content analysis was made from the data. The analysis concentrated on the pianists' comments about the keyboard and its connections with visual, auditory, and kinesthetic modalities, the three modalities forming also the themes of the interview.

Observation of the pianists while performing the two pieces formed supplementary material. The observation concentrated on visual feedback and finger and hand movements made by the pianists during performance.

IV. RESULTS

When the results are presented, the focus will be on the utilisation of the keyboard, the main interest being in the differences between performances of the tonal and the non-tonal compositions. The results are based on both the observation of the pianists during the performance and comments expressed by them in the interviews.

A. Tonal Versus Non-Tonal Compositions

While sight-reading the tonal composition, the pianists seldom looked at the keyboard, whereas during the performance of the non-tonal (contemporary) composition they looked at the keyboard frequently. In performing the tonal composition, pianists viewed the keyboard when there was a chord change or line change in the score. In performing the non-tonal composition, pianists looked at the keyboard when seeing (non-tonal) chords or interval combinations, as well as added lines in the score. Furthermore, with both the tonal and the non-tonal composition the pianists looked at the keyboard when there was a clef change in the score.

Pianists' comments revealed obvious differences between the performances of these two compositions. According to the pianists, it was unnecessary to look at the keyboard while performing the tonal composition because of the familiarity of the musical style (in comparison with the non-tonal style). The score of the non-tonal composition, on the other hand, seemed to consist of "notes scattered on the staves", and seemed to contain neither chords nor other features familiar to them. Hence, it was necessary to view the keyboard in order to perform the notes within the score—and, according to the pianists, this was on some occasions the only way to manage.

In sum, visual feedback did not appear to play a significant role in performing the tonal composition, whereas the pianists unanimously agreed on the central role of visual feedback in performing the non-tonal composition. The data received by observation supported the comments expressed by the pianists. Visual feedback seemed to be strongly connected with style-dependent factors, especially interval and chord patterns which occurred within the score of the non-tonal composition. The only style-independent factors seemed to be line and clef changes and additive lines.

Some of the pianists said that they could "see and know" (i.e., recognize) the chords of the tonal composition within the score. This "knowing" included the chord with association of the keys at the keyboard; in addition, the chord together with the pattern (that was seen in the score) recalled certain (motor) movement of the hand and fingers. Additionally, some said that they could imagine (in their minds) the keys to be used on the keyboard when seeing the tonal patterns within the score. Furthermore, one of them could also "feel" the tonal phenomenon "in her fingers", and simultaneously have an image of both sounds to be produced and the keys at the keyboard corresponding to the sounds. There was a considerable consensus among the pianists that, when playing the tonal composition, they utilised auditory feedback (i.e., the sounds that were produced and heard) in order to be capable of keeping themselves "on the map" (as one of them put it) without looking at the keyboard.

Altogether, the pianists' comments concerning the performance of the tonal composition seemed to refer to aspects involving the implicit utilisation of the information provided by the keyboard, instead of actual visual feedback. The comments also suggested that the implicit aspects indicated a generation of imageries in which the three modalities were involved.

B. The Combinations of Imageries and the Conceptualisation of the Information Available in the Score

All the comments presented above indicate that the pianists could comprehend the score of the tonal composition. The familiarity of the musical style made the comprehension relatively easy; in other words, the pianists processed familiar idioms (that is, idioms characteristic of tonal style) with great skill. When processing the score successfully, the pianists seemed to have simultaneously converted the patterns into (visual, auditory, and kinesthetic) imageries. However, there were individual differences between the pianists in conceptualising the idioms within the score.

The comments of the pianists showed that some of them conceptualised the left-hand broken chords as absolute chords. The conceptualisation involved "knowing" the chord (as an absolute chord) as well as "the knowledge" about which keys at the keyboard corresponded to the notes of the (absolute) chord identified in the score. The conceptualising of the chords seemed to aim at generating kinesthetic imageries—i.e., "kinesthetic models"—which resulted in the execution of (real) kinesthetic actions. The models were partly pre-defined; the keys involved in the chord, as well as the (certain) movement of the hand (which possibly consisted of a certain fingering), were known in advance. On the other hand, the models were open; the execution of specific actions (that is, in which order the keys were to be pressed down), could be, to some extent, free (some kind of improvisation using a certain absolute chord). The conceptualisation of absolute chords seemed to be partially absolute by nature, which refers to other kinds of ways to organise the score than the analysis based on Western art music. The processing described above can be characterized as a combination of visual and kinesthetic imageries.

Additionally, the analysis of the data revealed evidence of (visual-) auditory-kinesthetic imageries, in which the pianists seemed to have primarily converted the identified patterns into auditory representations. Within this process the chords or other patterns identified in the score were integrated within the current key (and harmony), and the processing resulted in key-dependent organisation of the information provided by the keyboard. Simultaneously, the processing involved the (kinesthetic) imagery of "feeling" the fingers, which resulted in flexible finger movements in the performance. The tactile-like feeling of fingers in connection with auditory imagery about the notes to be played seemed to be situation-dependent. The flexibility of the process was likely due to the auditory imageries (that is, the utilising of "inner ear"), which seemed to be partially generated in connection with auditory feedback in the sight-reading performance.

Since exact information on the combination of (visual-) auditory-kinesthetic imagery was not achieved, the delineating of this process remains somewhat inaccurate.

V. CONCLUSIONS

The variability in utilising the visual feedback suggests that the musical style is an essential factor for the role of visual feedback in sight-reading. The results partially support the assumption that visual feedback could be some kind of a prerequisite for sight-reading (Banton 1995), but this seems only to be the case in a non-tonal context and with factors independent of musical style. From the point of view of style-independent factors, the ability to perform without visual feedback seems to be a secondary skill in sight-reading (cf. Lehmann and Ericsson 1996). In a tonal context, however, this ability can be considered rather an epiphenomenon. The pianists seemed to utilise visual feedback whenever they were unable to generate imageries; thus, visual feedback seemed to serve to substitute for imageries, and it played an essential role in pianists' efforts at achieving fluency in the sight-reading performance.

The imageries, on the contrary, were a consequence of the pianists' ability to successfully process the idioms within the score of the tonal composition. It seemed that the pianists were able to generate imageries when the processing of the score was effective and possible. These results are in line with previous findings indicating that the ability to create a large perceptual span (Goolsby 1994) and to recognize patterns (Wolf 1976; Waters, Townsend and Underwood 1998), as well as the awareness of structural factors in the score (Sloboda 1976, 1977; Gingras, McAdams and Schubert 2007) are important components of fluent sight-reading. The results also provide further evidence of the assumption that prior knowledge of music structure and theory is essential for effective sight-reading (Sloboda 1984; Lehmann and Ericsson 1996; Waters, Townsend and Underwood 1998). The results suggest that the pianists had extensive experience in idioms involved in tonal music. However, the previous studies were almost exclusively based on the processing of the score, a viewpoint including a risk that sight-reading is solely seen as 'input' skills or an ability to organise notation in the score.

The connection between the ways of organising the notes in the score of the tonal composition and the ways of generating the imageries indicates that sight-reading performance is multidimensional in nature. Since the keyboard proved to be a salient component in converting the information within the score into visual-kinesthetic and (visual-) auditory-kinesthetic imageries, it could even be characterized as a mediator between the processing of the (idioms within the) score and the execution of the (appropriate) motor actions. The process of generating imageries, in which the keyboard was involved, seemed to include some kind of recoding process (see Miller 1956), which resulted in an (individual) ability to conceptualise the idioms. Thus, the knowledge of the organisational aspects implicit in the information provided by the keyboard was presumably crystallized in the process of generating imageries.

The connections between 'input' and 'output' skills, as well as the function of feedback in relation to these skills, have generally not been discussed in previous studies. The results indicate that the translation of the information available in the score into imageries was dependent on the processing of the score. Furthermore, the modality that was emphasized in the imageries affected the ways of processing the keyboard as well as the ways of executing the kinesthetic actions. The aspect of visual-kinesthetic imagery can be supposed to approach the principle of the overlearned response sequences (standard fingerings) triggered by visual patterns within the score (Sloboda, Clarke, Parncutt and Raekallio 1998). However, the results also indicate that the pianists showed individual means in converting the score into visual-kinesthetic imageries. The

processing of chords seemed to be partially based on practice-specific activities, resulting in the "improvisatory" treatment of a (certain) absolute chord (cf. Sudnow 2001). In addition, the findings reveal that motor actions involved other individual ways of conceptualising notation, such as generating auditory-like imageries (which resulted in (visual-) auditory-kinesthetic imageries). It also seems that when the pianists were able to generate imageries auditory feedback was involved in the performance.

The comparison between the two stylistically different compositions indicated that the ability to sight-read without visual feedback (that is, an ability to generate imageries involving the keyboard and performance at the keyboard) is not included in "general" skilled sight-reading; it is rather a question of the knowledge of musical style and theory, as well as the musical contexts within which the pianists have become accustomed to act. Thus, the skills are connected with general musical factors, such as the culture (including pianists' current repertoire; Lehmann and Ericsson 1996; Sloboda, Clarke, Parncutt and Raekallio 1998) and the cultivation in domain-related activities (cf. Lehmann and Ericsson 1993, 1996). The pianists' ability to deploy knowledge based on the improvisation activities in the context of idioms typical of Western art music indicates that sight-reading may also involve an ability to act beyond the boundaries of different practices. In addition, the pianists' performance also seemed to involve individual cognitive processing (e.g., making choices and directing one's attention). Thus, without considering the perspectives discussed above, pianists cannot unambiguously be assessed into skilled and less skilled sight-readers (cf. Sloboda 1976; Goolsby 1994; Banton 1995; Lehmann and Ericsson 1996; Waters, Townsend and Underwood 1998). It seems that instead of considering the (general) ability to sight-read, it could be more important to focus on both the context-dependent and the individual means by which a performer may approach a composition unknown to him or her.

Case study, with both a video-taped performance and an interview, proved to be an appropriate procedure for the investigation of sight-reading. The advantages of the interview as a research method are indisputable; the discussion with the pianists offered a fertile ground for examining the aspects underlying their actions. The processes that could not be directly observed proved to be the most important material in the data. One of the issues in considering the validity of the study concerns how far the researcher's constructions are grounded in the constructions of the participants. The three themes used in the interviews were supposed to increase the correspondence between the constructions of the researcher and the pianists. Additionally, the discussion in the interviews touched on the themes at a practical level, so that the data consisted of issues arising from the pianists' everyday experience.

However, as the number of participants was limited, it is not possible to generalise the results and conclusions. There also seemed to be variation among these pianists, and there were probably additional factors underlying the pianists' processing that could not be seen within this procedure. Nonetheless, it is likely that the described combinations of the imageries, in which the keyboard was involved, captured some essential elements of the multi-modal and overlapping processes involved in sight-reading at the piano. By studying these processes it was possible to find some implications of how individual pianists organised the score.

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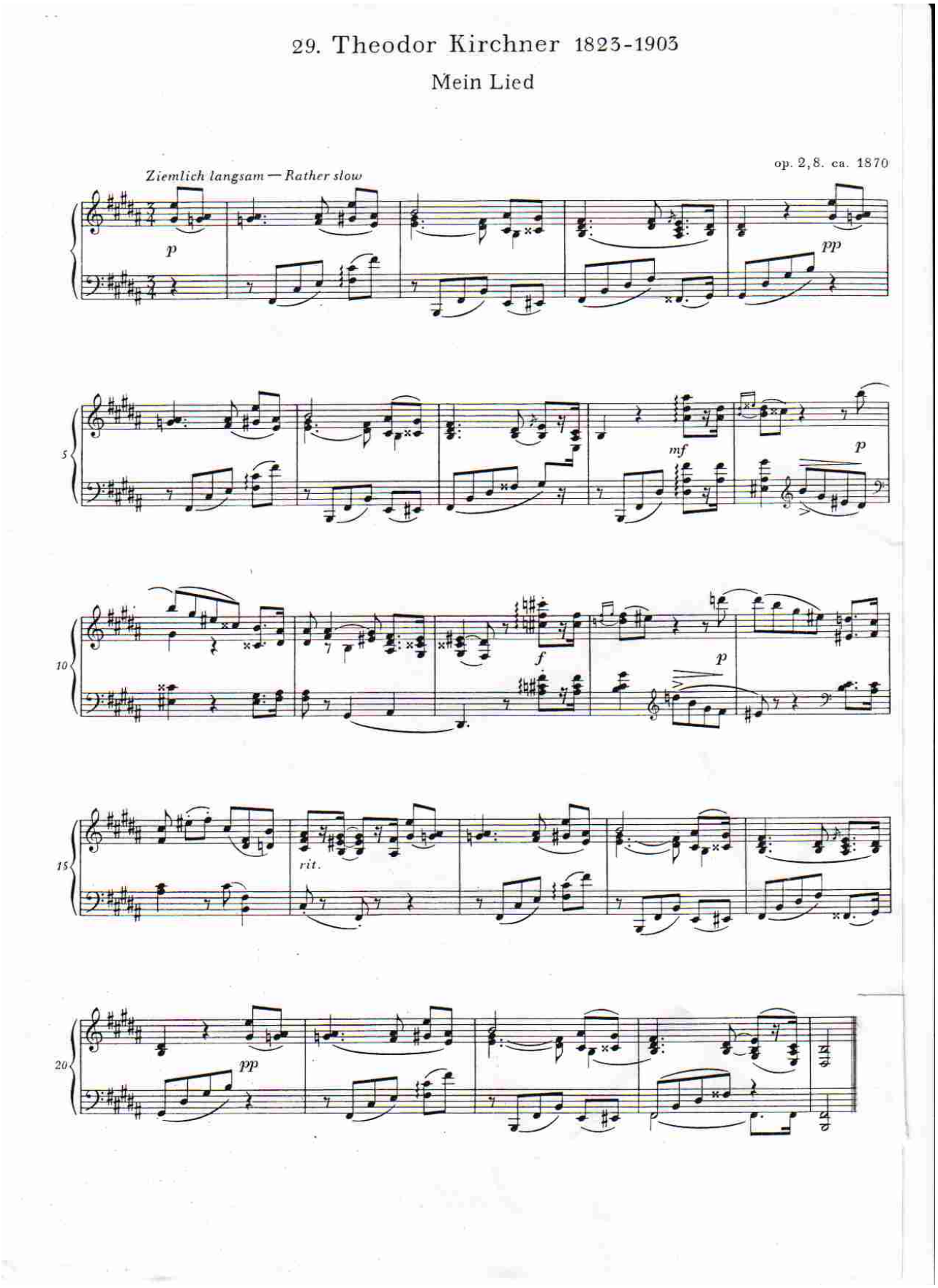
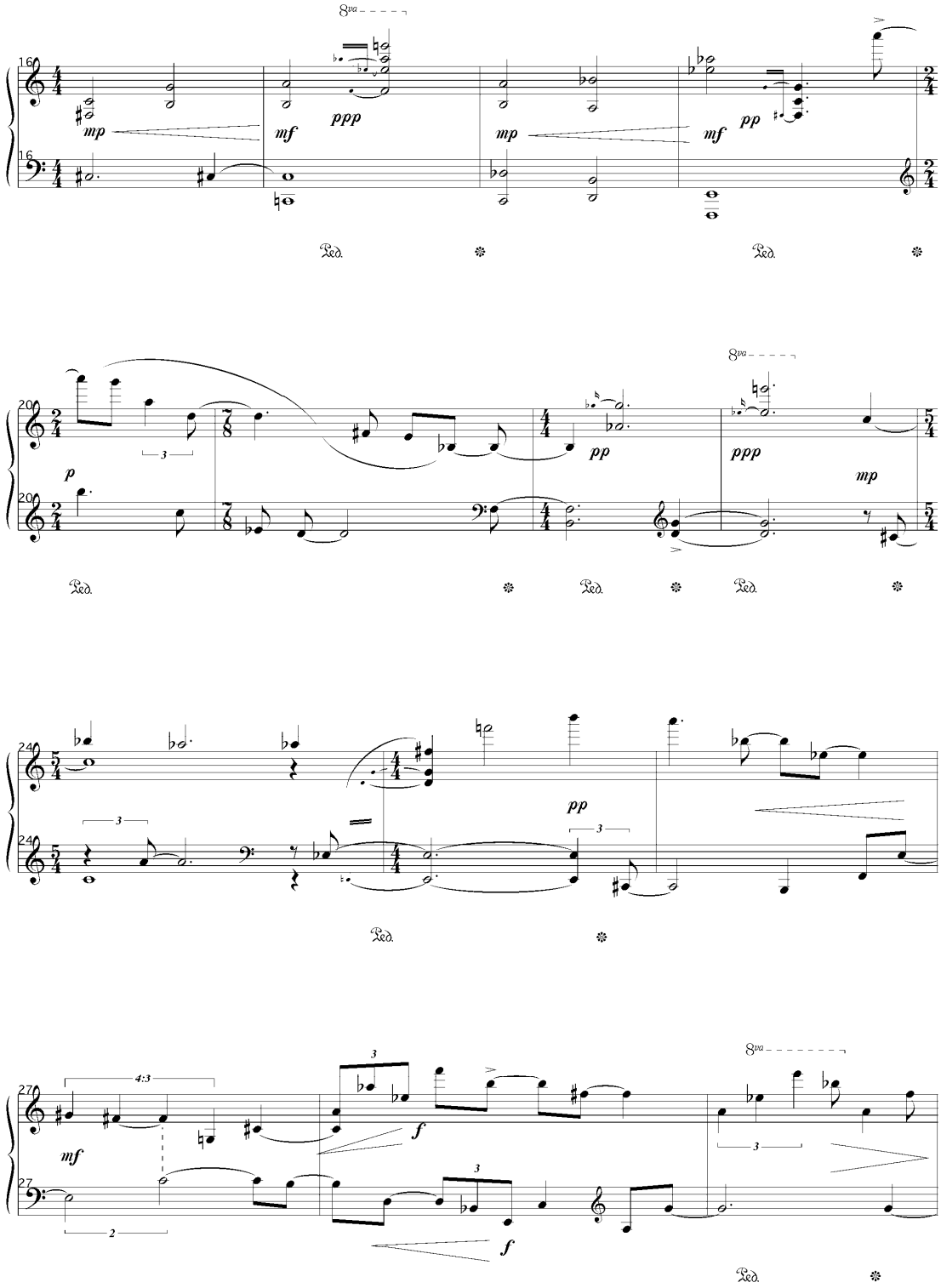
Appendix 1: Tonal composition



Appendix 2: Non-tonal composition (middle page)



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