Toward a model of performance errors:
A qualitative review of Magaloff's Chopin

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Musicians at all levels of proficiency must deal with performance errors and have to find strategies for avoiding them. Performance errors have been investigated before, but most studies focus on data gathered under laboratory conditions. We present a study conducted on a unique corpus of precisely measured performances: the complete works for solo piano by Chopin, performed on stage by the Russian pianist Nikita Magaloff, recorded on a Bösendorfer SE computer-controlled grand piano in a series of public recitals in Vienna in 1989. We classify groups of errors, analyze their context and the patterns they form, and discuss probable causes.

Keywords: piano performance; performance errors; error catalogue; error model; Chopin corpus

Performance errors are a perennial issue for musicians, both when practicing in private and when performing in public. Due to the lack of precisely measured performance data, empirical investigations of the phenomenon are limited. Previous studies (Flossmann *et al.* 2009, Flossmann *et al.* 2010b) focused on single-note errors, their immediate context, and their relation to performance tempo. The goal of the present study was to build and analyze groups of errors, the context in which they occur, the patterns they form, and what conclusions can be drawn as to the potential causes.

A study seminal to this approach is Palmer and van de Sande (1993), which relates single-note production errors to units of mental representation of music. The authors conclude that the units in which music is stored and retrieved from memory depend on the musical context. Further, insertion and substitution errors are more likely to involve harmonically or diatonically

related notes. Repp (1996) focused on the perception aspect of performance errors and investigated how obvious errors are to a concert audience.

METHOD

The data we analyzed are a unique resource of live piano performances: the Magaloff corpus (Flossmann *et al.* 2010b) comprises the complete works of Chopin performed on stage by the Russian pianist Nikita Magaloff on a Bösendorfer computer-controlled grand piano and recorded in MIDI. The MIDI data were aligned to musicXML representations of the Henle Urtext Edition (Zimmerman 1976-2004) of the score, which resulted in a fully an-notated performance corpus. The errors were marked as insertion, deletion, and substitution errors.

For a part of the corpus (4 Ballades, 24 Preludes Op. 28, 24 Études Opp. 10 and 25, 17 Nocturnes), we categorized errors (single errors or groups of errors) manually into error patterns. We identified most likely causes for prototypical instances of the categories (e.g. idiosyncratic interpretation, memorization, technical simplification). We excluded 134 insertion errors with very low MIDI velocities because we cannot exclude the possibility that they were measurement artifacts. We also excluded 229 deletion errors (Op. 25 No. 10, bars 101-102, and Op. 32 No.2, bars 64-69) that are most likely the result of differences between our edition of the scores and that of Magaloff.

In total, 36% of the insertion notes, 44% of the deletion notes, and 44% of all substituted notes in the pieces were assigned to the established categories. The remaining errors could not be distinguished further. Table 1 shows the error categories with their respective error counts.

Table 1. Number of errors in the different categories.

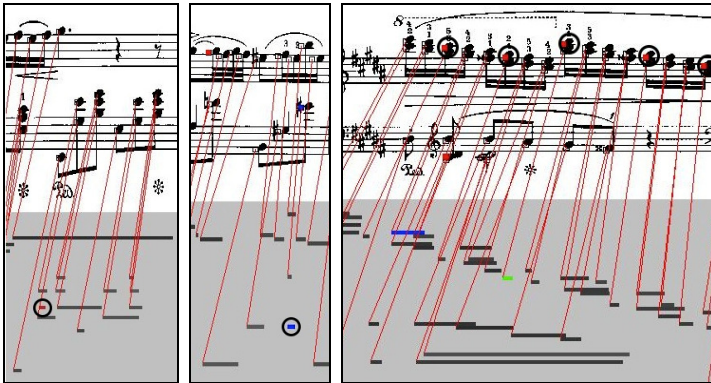| Category	Insertions	Omissions	Substitutions
Omitted inner voice	-	630	-
Forward-related errors	59	9	40
Backward-related errors	75	8	53
Unharmonic errors	694	-	88
Harmonic errors	104	-	69
Tied notes	91	294	-
Repeated notes	123	-	-
Systematic errors	228	555	110
Note order errors	-	-	261
Total	*1385*	*1496*	*635*

Figure 1. Forward-related insertion in Nocturne Op. 9 No. 2 (left); repeated note in Nocturne Op. 9 No. 3 (middle); systematic deletion in Étude Op. 25 No. 10.
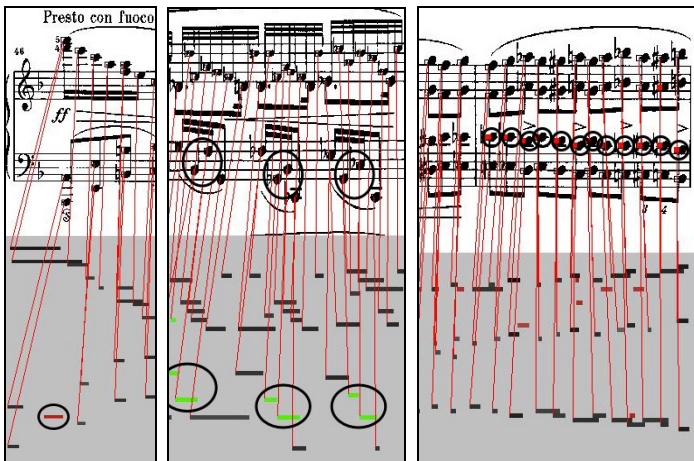

Figure 2. Systematic insertion in Ballade Op. 38, bar 46 (left); note order error in Prelude Op. 28 No. 8 (middle); omitted inner voice in Étude Op. 25 No. 10 (right). (See full color version at www.performancescience.org.)

RESULTS

Several distinct error patterns emerged, covering roughly 40% of the errors in the pieces examined. Below, we provide a brief explanation of the different categories and discuss prototypical examples.

Forward- and backward-related errors

Errors in this category have a clear forward or backward relation. Figure 1 shows a typical example: the pitch B*b* in the immediately following chord causes the insertion. Analogous situations occur for substitutions and omissions with both forward and backward relations. In almost all cases, the most probable cause is a memorization problem.

Repeated notes

Repeated notes are a special form of backward-related insertions that are unrelated to the metrical grid: a note that was (likely unintentionally) played twice. In many cases, one of the performed notes is much softer than the other one. Possible causes include a silent change of fingering for the note where the finger was lifted too high in the transfer, thus striking the note twice. Figure 1 shows a typical example.

Unharmonic errors

Errors that obviously disrupted the harmonic context were classified as unharmonic. This mainly involves insertions at a significant MIDI velocity a semitone above or below the notated pitch. A large percentage (46%) occurred in octave runs in either one or both hands.

Harmonic errors

Insertion or substitution notes associated with this category do not disrupt the harmonic context of the piece. In most cases, these are added octaves in the accompaniment or accompanying notes that were shifted by one octave. While the latter points to a memorization problem, the former could also be deliberate harmonic emphasis. Rare cases involve added figurative elements, such as trills, that were not notated in the score.

Tied notes

Two kinds of errors are related to the concept of tied notes. (1) A tied note might be struck again, resulting in an insertion note; this is either a problem of memorization (mostly in inner voices) or done intentionally to emphasize a melody line that otherwise lacked continuation. (2) Two successive notes of the same pitch might be played only once, as if they were notated as tied, resulting in an omission of the second note; in most cases this seems to be caused by the need for technical simplification.

Systematic errors

We call an error systematic if it occurs in more than 60% of instances of the same or an analogous context. This covers a variety of situations. Figure 2 shows a systematic insertion from Ballade Op. 38: in almost all instances in which the right hand starts with a downward run, accompanied by a rising sequence of octaves in the left hand (e.g. bars 46, 48, 50), Magaloff inserted a note shortly before or after the first octave in the left hand, probably for technical reasons. Étude Op. 25 No. 6 contains several downward runs in thirds. In each of these runs, Magaloff omitted notes from the highest voice at regular intervals (every third or fourth note). The regularity suggests a technical problem with the fingering in this passage. In Étude Op. 25 No.1, Magaloff often omitted the second note of the figure in the left hand. This suggests a weak third finger and a problem covering the large span required in the left hand. A systematic substitution can, for instance, be found in Étude Op. 25 No.6, bars 7 and 8, where Magaloff consistently played A instead of A#. This is probably due to a problem of memorization.

Omitted inner voice

A special case of systematic deletion is the omission of an inner voice: throughout a sequence of onsets, an inner voice is omitted partially or completely. In most instances the most likely cause is either a memorization problem (the least significant voice was simply forgotten) or the need for technical simplification, depending on the complexity of the passage. For instance, in Étude Op. 25 No.10, bar 16 (Figure 2), Magaloff omitted one of the two inner voices from a sequence in which the two hands move in parallel octaves. In this highly homogeneous context, the omission is very obvious to the audience and clearly not a problem of memorization but a result of the technically demanding nature of the piece.

Note order errors

These errors form the only category that relates to timing: the order in which two (or more) successive notes are played is switched, resulting in two (or more) substitution notes. Instances of this pattern are mainly found in Étude Op. 25 No. 3 and Prelude Op. 28 No. 8. In both pieces, the affected group of notes is a descending pattern in the left hand, consisting of four notes. In the étude, the lower of the two notes at the first onset is played after the third note in the group, resulting in a downward sequence of four notes. In the prelude, the affected group is very similar, with the slight difference that the

first two notes are to be played successively instead of simultaneously. Again, the two middle notes are often switched, producing the same downward sequence as in the étude. Figure 2 shows an excerpt from the prelude. As the performance tempo of both pieces is high, the change in note order is hard to notice. This suggests intentional simplification as the reason for the error.

DISCUSSION

This study is part of a series of investigations of a unique resource of onstage performances. Categorizing the errors in them allows an inventory of possible error situations to be built. Studying sequences of errors, the context and patterns in which they occur, and their likely causes can help build a model of errors in piano performances. Given suitable data, it would also be interesting to compare how other pianists cope with technically demanding situations: whether they share techniques to simplify passages by harmonic substitutions and whether there are pieces that all find particularly hard to memorize.

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