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Abstract

Little empirical research has been conducted on prodigies, in no small part due to the fact that there exists no agreed-upon definition with which to identify them. The most widespread definition characterizes a prodigy as a child who, at a very young age (typically before 10) performs at an adult professional level (Feldman & Goldsmith, 1986). We tested this definition by asking musicians and non-musicians to (1) judge whether audio clips were played by a prodigy or a professional and (2) identify which of two clips of the same piece was played by a prodigy. Listeners performed above chance in both tasks but by a very modest margin, and musicians performed better than non-musicians. Their low performance implies that prodigies perform well enough to be judged in terms of the most demanding criteria of performance in the field. Yet older prodigies (11 to 14) were harder to distinguish from professionals than younger prodigies (under 10), suggesting a protracted developmental trajectory for prodigy performance. Furthermore, the rate at which prodigies progressed in their playing appears higher than for regular students, suggesting that rate of progress might be used as an additional criterion for defining music prodigy.

Keywords: music prodigies, musical talent, musical performance, young performers, rate of progress

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43 Can You Tell a Prodigy from a Professional Musician?

44 A prodigy is a highly-gifted child who belongs to a rare group of individuals who are at
45 the extreme in their area of ability (Von Károlyi & Winner, 2005). Although there are prodigies
46 in a few domains, such as chess, calculation, and to a lesser extent visual arts, music is the most
47 common (Jenkins, 2005). Even if many musicians agree that the outstandingly gifted child is
48 immediately recognizable, unmistakable, and very rare (Shuter-Dyson, 1985), there is
49 considerable disagreement regarding how the prodigy should or could be defined. Academic
50 giftedness is often defined operationally as an extremely high level of general intelligence on
51 standardised IQ tests or very precocious levels of performance in formal educational settings
52 (Geake, 2009). Operationalizing a definition for music prodigies proves to be much harder,
53 particularly when it comes to specify at what age, and against what standard, a child would have
54 to be called a prodigy (Feldman, 1993). Very little empirical research has been conducted on the
55 phenomenon, in no small part due to the fact that there exists no agreed upon definition with
56 which to identify music prodigies.

57 Considering the lack of a definition, Feldman (1993) proposed that a prodigy is “A child
58 (typically younger than 10 years old) who is performing at the level of a highly-trained adult in a
59 very demanding field of endeavor” (p. 188). According to its author, this definition was meant to
60 stimulate and guide research while at the same time, be explicit and precise enough to be tested
61 empirically (Feldman & Morelock, 2011). In this definition, two main factors characterize a
62 prodigy: precocity and level of achievement.

63 Most researchers agree that precocity is an essential characteristic of a prodigy (Geake,
64 2009; Howard, 2008; Jenkins, 2005; McPherson, 2006, 2007; Ruthsatz & Urbach, 2012;
65 Vandervert, 2009; Winner, 1996a). For Shavinina (2010), the age boundary is precisely what

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distinguishes a prodigy from a very gifted child, as prodigies are able to realize a task that is usually accomplished by adults only. The question comes down to what level of achievement needs to be attained to constitute an extraordinary level (Mayer, 2005; Rindermann, Ceci, & Williams, 2013). In Feldman's definition, a prodigy is measured against the standard of a professional adult. A prodigy not only shows more talent than other children of the same age but must also be judged in terms of the most demanding criteria for performance in that field regardless of age (Feldman & Goldsmith, 1986). Many have since promoted the idea that a prodigy's performance must be impressive by adult standards (Radford, 1990; Robinson, 2000; Winner, 1996b, 2000).

Rapid learning (Jackson, 2000) or quick ascent to a high performance level (McPherson, 1993) also characterizes child prodigies. In international chess competition, for example, not all children start playing chess very early on but they quickly reach high performance levels (Howard, 2008). Thus, rate of progress is another criterion that might be worth considering in defining a music prodigy.

Any empirical study of prodigy development requires an operational definition. In the current paper, we tested Feldman's definition and asked whether prodigies do perform at an adult professional level. To these aims, we searched the Internet for musical performances of the same pieces by prodigies and by professionals. We selected and edited 165 such clips and presented only the audio to musicians and non-musicians. The task was to identify whether a prodigy or a professional was playing the music. Additionally, we assessed whether prodigies reach a high level of performance in a very short period of time. To do this, we estimated a rate of progress for each prodigy using the difficulty of each prodigy's repertoire and the number of years that the prodigy had been playing the piano.

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89 **Method**90 **Participants**

91 Twenty-six musicians and 25 non-musicians between 19 and 65 years old ($M = 33.5$, SD
92 $= 13.0$) were recruited from the University of Ottawa and the Université de Montréal. The non-
93 musician group consisted of adults who do not currently play an instrument and who have never
94 had private music lessons. The musicians' group consisted of 5 professional musicians, 10
95 teachers and 11 students; 17 of them had piano as their primary instrument.

96 **Stimuli**

97 One hundred sixty-five video clips of piano performances (Appendix A) were collected
98 from various sources, including talk shows, news broadcasts and concert recordings on
99 YouTube. For any given musical excerpt, we selected one performance by a prodigy and one by
100 a professional. Prodigies were 14 years old or less at the time of the recording. They had all
101 received social recognition as outstanding performers by the media or by music critics. The
102 majority of the professionals were well-known adult piano soloists.

103 The grade level of each selected classical piece was judged according to the piano
104 pedagogy standards of the Royal Conservatory of Music (2015), as grade 8, 9, 10, ARCT (for the
105 Associate of the Royal Conservatory diploma) and playing with an orchestra, as reflecting an
106 increasing order of difficulty. The concerti clips were always solo piano excerpts so that they
107 would not be masked by the sound of the orchestra. The audio clips were edited to start with the
108 beginning of the piece and end with a musical phrase boundary, creating a corpus of clips with
109 an average length of 42.0 seconds ($SD = 15.4$; range: 15-128). Professionals' performances
110 tended to be recorded with higher quality equipment than prodigies' performances; this was the
111 case for 79 out of 165 clips. Note, however, that a few professional clips were from old

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recordings with lower quality sound (i.e., Horowitz, Schnabel). The 79 clips that had been recorded at higher quality were edited with the *Fruity Loops* software and adjusted for ambient noise, acoustic field, echo and sound frequency equalization in order to match the recording quality between the clips of prodigies and professionals. These adjustments were always made by adding noise to the higher quality recording. No sound compression was applied in order to keep the dynamic range intact.

In order to examine whether there were residual recording differences, an independent sample of 15 musicians and 16 non-musicians were presented with the 79 edited pairs of audio-clips. For each pair, they had to judge which one had a more professional/amateur recording quality. All participants could hear the difference, with discrimination scores being above chance for both musicians, $t(14) = 11.06, p < .001$, and non-musicians, $t(15) = 11.06, p < .001$. There was no significant difference between the scores of musicians and non-musicians, $t(29) = 0.68, p > .05$. The putative influence of quality differences on participants' identification of the child prodigy will be examined in the results section.

Procedure

Audio clips were presented to participants through a website powered by the Open Video Toolkit (Marchionini & Geisler, 2002), so that the tasks could be completed from a personal computer at home. Participants completed an identification task followed by a comparison task, at their own pace.

Identification task. 108 clips (4 of Grade 8, 14 Grade 9, 24 Grade 10, 56 ARCT and 10 Concerto), half of which were performed by a child prodigy, were presented one at a time to the participants. The task was to judge whether the clip was played by a child prodigy or a professional adult, and to rate how difficult the decision was on a 1 to 5 point scale with '1'

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being very easy and ‘5’ very difficult (Figure 1). The task was divided into four blocks of 40 audio clips each. The first block contained performances of adult professionals and young prodigies (under the age of 10), the second block contained performances of professionals and older prodigies (11-14 years), and the last two blocks contained performances of professionals and prodigies of all ages. Fifty-three clips from the first two blocks reappeared in the last two blocks; therefore, the judgments for these repeated clips were not included in the main analysis, only in the analysis of judgment consistency. The listening order of the blocks was randomly assigned to each participant. Clips were pseudo-randomly arranged in each block so that two performances of the same musical piece were never presented back to back.

[insert Figure 1]

Comparison task. 64 audio clips (2 Grade 8, 4 Grade 9, 16 Grade 10, 36 ARCT, 6 Concerto) were presented in pairs in which a child prodigy and an adult professional played the same excerpt of the same classical piece. 14 of these clips had also been presented during the identification task. Order of presentation (prodigy then professional vs. professional then prodigy) was counterbalanced across trials. Participants had to decide which of the two audio clips was played by a child prodigy and to rate how difficult it was to make each judgment on a 1 to 5 point scale.

Results

Musicians were able to distinguish prodigies from professionals with an average score of 62.6% ($SD = 7.5$) and 73.9% ($SD = 8.5$) for the identification and comparison tasks, respectively, while non-musicians performed at 52.8% ($SD = 5.0$) and 61.9% ($SD = 14.0$), respectively (Figure 2). A t-test analysis comparing their accuracy to chance level (50%) revealed that musicians performed above chance in the identification and comparison tasks, $t(24) = 8.17$, $p < .001$ and

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$t(24) = 14.90, p < .001$, respectively, as did non-musicians, $t(24) = 2.84, p = .01$ and $t(24) = 4.27, p < .001$, respectively. A repeated measures ANOVA with the tasks (identification, comparison) as the within-subject variable and expertise (musicians, non-musician) as the between-subject variable, showed that musicians generally performed better than non-musicians, $F(1, 49) = 29.04, p < .001$, and that the comparison task was easier than the identification task, $F(1, 49) = 37.16, p < .001$ (Figure 2). There was no interaction between musicianship and task, $F(1, 49) = 0.44, p > .05$.

[insert Figure 2]

Prodigy Age

The effect of the block, which roughly corresponded to prodigy age, on accuracy was assessed using repeated measures ANOVA, with Block (Young Prodigies, Old Prodigies, mixed-aged Prodigies) as a within-subject factor and Musicianship (musician, non-musician) as a between-subject factor. Note that judgments were independent in the different blocks because no one audio clip was included in more than one block (age category). As shown in Figure 3A, all participants distinguished the younger prodigies better than the older prodigies, $F(2, 90) = 8.98, p < .001$ (Huynh-Feldt corrected, $\epsilon = 0.92$). Musicians outperformed non-musicians for all age groups, $F(1, 49) = 28.46, p < .001$. There was no significant interaction between prodigy age and Musicianship, $p > .05$.

[insert Figure 3]

Prodigy age affected musicians' difficulty ratings more than nonmusicians', with musicians finding it easier to identify young prodigies, $t(49) = 2.93, p < .01$ (Figure 3B). This was supported by an interaction between Musicianship and Age group, $F(2, 98) = 4.58, p < .01$.

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A similar pattern emerged in the comparison task, with a significant interaction between Musicianship and Block, $F(1, 49) = 4.73$, $p < .05$, indicating that musicians had higher scores when comparing professionals to young prodigies than to older prodigies, $t(49) = 4.58$, $p < .001$, and that musicians had higher scores than non-musicians only with the younger prodigies, $t(49) = 4.17$, $p < .001$ (Figure 4A). Figure 4B shows the significant interaction between Musicianship and Age group for difficulty rating, $F(1, 49) = 5.18$, $p < .05$, confirming that musicians found it easier to compare professionals to young prodigies than to older prodigies, $t(49) = 3.03$, $p < .01$.

[insert Figure 4]

Piece Difficulty

The effect of grade level on participants' identification of child prodigies was analyzed with a repeated measures ANOVA, with Grade level (8, 9, 10, ARCT and concerto) as a within-subject factor and Musicianship (musician, non-musician) as a between-subject factor. Figure 5 shows that the higher the grade level, the lower the scores, with a linear trend being significant for both musicians, $F(4, 125) = 18.2$, $p < .001$, adjusted $R^2 = 0.35$, and non-musicians, $F(4, 120) = 3.88$, $p < .01$, adjusted $R^2 = 0.09$. The analysis also revealed an interaction between Grade level and Musicianship, $F(4, 176) = 7.0$, $p < .001$ (Huynh-Feldt corrected, $\epsilon = 0.89$), with musicians having higher scores than non-musicians for all grade levels, all t values > 2.24 , all p values $< .05$, except for concertos, $t(49) = 0.49$, $p > .05$.

[insert Figure 5]

Measures of Sensitivity and Bias

A limitation of the analyses above is the possibility that the participants were biased in their judgments (i.e., individuals tending to always respond "professional" or "prodigy"). One way to take into account bias in judgments is to calculate sensitivity (d') by subtracting the false

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alarm rate (i.e. judging a professional's performance as being played by a prodigy) from the hit rate (i.e. correct identification of a prodigy's performance) (Macmillan & Creelman, 2005). Bias (c) represents half the sum of false alarms and hits rates, with higher values meaning a more conservative bias. Bias and sensitivity were only measured for the identification task since the comparison task did not allow the distinction of hits from false alarms.

The effect of expertise and block (prodigy age) on bias and sensitivity was assessed with a repeated measures ANOVA. As shown in Figure 6A, musicians had a higher sensitivity than non-musicians regardless of the block, $F(1, 49) = 22.62, p < .001$, and block had a main effect on sensitivity, $F(1, 49) = 4.69, p < .05$. The analysis of bias shows that all participants had a conservative bias ($c > 0$); they tend to evaluate the musical performances as being played by adult professionals, $t(152) = 60.20, p < .001$.

[insert Figure 6]

In order to determine if the capacity to distinguish prodigies from adult professionals was reliable, the sensitivity of each participant was correlated with their difficulty rating for each judgment made. The correlation was marginally significant for musicians, $t(24) = -1.96, p = 0.06, R = -.37$, but not significant for non-musicians, $t(23) = 0.37, p = .71, R = 0.078$. This indicates that non-musicians were less aware than musicians of the accuracy of their judgments.

Judgment Consistency

Since 53 audio clips were repeated, it is possible to assess whether participants were consistent in their judgments. This was measured in percentage of identical judgments made by each participant for each set of duplicate recordings. A repeated measures ANOVA, with the Performer (prodigy, professional) as a within-subject factor and Musicianship (musicians, non-musicians) as a between-subjects factor, revealed that musicians were generally more consistent

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than non-musicians, $F(1, 48) = 4.73$, $p < .05$ and that consistency did not depend on the type of performer, $F(2, 96) = 0.61$, $p > .05$, and. There was no significant interaction between Performer and Musicianship, $p > .05$.

Acoustical Analysis

Various acoustical analyses of the clips were conducted to explore a possible acoustical basis for the judgments. To this aim, the Mirtoolbox (Lartillot, Toivainen, & Eerola, 2008) in Matlab2013a software was used to extract the average tempo and the standard deviation of tempo (default settings, 4-second time window). Similarly, Praat software (Boersma & Weenink, 2001) was used to extract the standard deviation of sound intensity. Praat extracts the intensity, in decibels, within each frame of the sound clip (based on its sampling rate), and uses these values to calculate a standard deviation value.

Variation of intensity. The standard deviation of sound intensity was measured for each audio clip, then averaged (if more than one clip) according to the performer (prodigy or professional) for each musical piece. A paired t-test comparing prodigy and professional performances of the same classical piece revealed that prodigies' performances varied in intensity less than professionals' performances, $t(67) = -2.92$, $p < .01$. To investigate the effect of prodigy age, the standard deviation of intensity was then compared between the performances played by young prodigies, older prodigies and adult professionals, independent of the piece presented. A linear trend significantly predicts the variability in intensity according to the performer's age, $F(2, 139) = 5.39$, $p < .01$, adjusted $R^2 = 0.059$: the older the performer, the higher the variation of intensity in performance. Post-hoc comparisons (Bonferroni-corrected) revealed that the difference in variation of intensity was significant between young and older

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248 prodigies, $t(72) = -2.24, p = .03$ but not significant between older prodigies and professionals,
 249 $t(105) = -0.97, p > .05$.

250 To determine if this variation of intensity was used by the listeners to distinguish
 251 prodigies from professionals, the average standard deviation of intensity was compared between
 252 the audio clips more often ($> 70\%$) judged as being played by a prodigy and the audio clips more
 253 often ($>70\%$) judged as being played by a professional. This difference is significant for
 254 musicians' judgments only, $t(58) = -2.54, p < .05$.

255 **Tempo.** The average tempo and the standard deviation of tempo were measured for each
 256 audio clip, then averaged (if more than one clip) according to the performer (prodigy or
 257 professional) for each musical piece. A paired t-test comparing prodigy and professional
 258 performances of the same classical piece revealed that the difference in the average tempo is
 259 only marginally significant, with professionals playing slightly faster than prodigies, $t(67) = -$
 260 $1.86, p = 0.066$. Standard deviation of tempo was not significantly different between
 261 professionals' or prodigies' performances, $t(67) = -1.71, p > .05$.

262 As with the variation of intensity, the average tempo and the standard deviation of tempo
 263 were compared between the performances played by young prodigies, older prodigies and adult
 264 professionals, independent of the classical piece. One-way ANOVAs revealed that there was a
 265 difference between the three groups for the average tempo, $F(2, 162) = 3.16, p < .05$, but not for
 266 the standard deviation of tempo, $F(2, 162) = 1.04, p > .05$. Post-hoc t-tests show that
 267 professionals played significantly faster than young prodigies, $t(120) = -2.39, p < .05$, but not
 268 than older prodigies, $t(123) = -1.38, p > .05$, and that there was no difference between older and
 269 younger prodigies, $t(81) = -1.00, p > .05$. Furthermore, there was no correlation between the

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tempo of the piece and participants' assessment of whether the performer is a prodigy or not in the identification task, $r(99) = .15, p = .13$.

Recording quality. Participants' ability to judge any one clip based on its recording quality was not correlated to their ability either to identify the performer (professional or prodigy) of those altered clips in the identification task, $r(44) = .09, p = .56$, or to distinguish the altered professional clips from their matched prodigy clips in the comparison task, $r(30) = .06, p = .75$. This result suggests that the participants (musician and non-musician alike) are using cues other than sound quality to make their judgments.

Rate of progress

Considering the unusual speed at which a young individual can master the performance skills of a domain, we estimated whether rate of progress could qualify as a criterion for the definition of a prodigy. This puts the focus on an age-based comparable, instead of an adult-based evaluation (Edmunds & Noel, 2003). To this aim, we examined the rate of progress by considering the RCM grade level of the pieces played by the child prodigies as a function of the number of years of piano playing at the time of performance. Of all the prodigies included in this study, one case was excluded (Lorenzo Mendel) due to his extreme outlier rate of 11 grades in one year. Nevertheless, prodigies progressed significantly faster than a sample of 277 piano students, even when the age at which training started, the number of years of playing were controlled for, $b = 1.35, SE = 0.14, p < .001$. Prodigies completed over two grades per year while, on average, regular students complete less than one grade.

Discussion

Even expert piano players have difficulties in judging whether short audio-clips have been played by a child prodigy or an adult professional. They manage to perform above chance,

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but barely. In fact, the 50 listeners, including musicians and laypeople, could not distinguish about a third of the prodigies from professional musicians. It is worth pointing out that under normal circumstances, children's piano performance is typically measured against age-relative standards, such as in competitions and examinations, and not against adult professional standards. However, we show here that performances by child prodigies are difficult to distinguish from those by adult professionals. Thus, we confirm that the music prodigy performs well enough to be judged in terms of the most demanding criteria for performance in the field, in line with Feldman's (1993) definition of a prodigy.

It may be the case that the audio clips were too short to allow the listeners to gauge the performance accurately. The clips lasted on average 45 s so as to be able to present many of them and cover a broad sample of prodigies in a manageable time for the listeners. Thompson and collaborators (2007) have addressed this issue with complete performances of whole pieces of Bach and Chopin. In their study, musicians rated overall quality, technical proficiency, assurance, and musicality continuously by moving a cursor on a computer screen. The results showed that judgments were made within the first 20 s of listening. By 60-90 s, listeners had typically "finalized" their evaluation with only small modifications or adjustments thereafter. Thus, the duration of the recording fragments presented here does not seem to be a key limiting factor.

Other factors may come into play in shaping listeners' evaluations of the clips presented in our experiment. For instance, familiarity with the repertoire and with the performer may help the expert listener to distinguish a student from a famous pianist. Pianists are used to hearing and even evaluating the pieces presented for examination according to the standards of the Royal Conservatory of Music (2005). They may also identify pianists by their touch and style. All these

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factors may contribute to the musicians' judgments. Interestingly, none of the musically-trained participants reported using such cues. At any rate, there are other aspects of the performances, like general appearance, that are clearly important in real life and were controlled here. Above all, the performances were audio-only. Listeners had no extra-musical information upon which to base their judgments. In a real performance setting, a host of other factors would play a part in determining a listener's evaluative response. For example, the contrast between the appearance of a very young child who can barely reach the piano pedals and that child's prodigious performance would undoubtedly contribute to the wonder of the audience. It is well-established that the performer's appearance and gender will affect the rating awarded in an evaluation. Hence, it might be hypothesized that in a real concert situation, an evaluative judgment might be made early on in favor of the child over the adult.

Here, we removed the sight of the performer in order to avoid the long-lasting impression that a child virtuoso will obviously elicit. Nevertheless, by listening to the audio only, laypeople and experts alike had trouble distinguishing older prodigies (11 to 14 years old) from adult professionals than younger ones (10 years and under). The 11-to-14 years-olds use similar dynamics (intensity variations) and tempi as adults do while the younger ones play slightly more slowly and with less dynamic range. This age difference probably reflects biomechanical differences. For a young child, it is difficult to play on an "adult-sized" instrument as hands, arm reach and arm weight are not yet fully developed. Cognitively, however, the age limit of 10 may still be valid as far as the definition of a prodigy is concerned. Future research should be aimed at investigating the potential dissociation between performance achievement and cognitive-perceptual abilities in musical prodigies.

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Another criterion relevant for the identification of music prodigies is the rate at which they progress relative to regular piano students. The biographies of numerous professional musicians indicate that they progressed very quickly early on. The case of the violinist Sarah Chang is illustrative (Gagné, 2007). She began violin studies at the age of four and by the age of eight, she was auditioning for Zubin Mehta and Riccardo Muti and secured immediate engagements with the New York Philharmonic and the Philadelphia Orchestra. In just four years after beginning violin lessons, she reached a level of performance that most music students never reach. Prodigies' average rate of progress, estimated here at two grades a year, is clearly distinct from that of regular music students. McPherson (1993) has calculated the typical rate of progress of candidates who undertake music performance examinations with the Australian Music Examination Board (AMEB). He points out that piano students progress through AMEB grades at a little over half (0.6) a grade level per year of study. This is very similar to the average rate of progress of the regular piano students included in this study (0.7 grades per year). Although our study, like McPherson's, acknowledges that prodigies learn at a faster rate than other children, this does not seem to be due to an earlier start. We found no evidence that prodigies progress faster because they started earlier and hence got more practice.

The discrepancy in rate of progress between prodigies and regular students challenges the position of Ericsson and colleagues (Ericsson, Roring, & Nandagopal, 2007; Howe, Davidson, & Sloboda, 1998) who maintain that expert performances can be entirely explained by the amount of deliberate practice. According to Ericsson, the rates of improvement on any performance task are the result of individual engagement in rigorous and focused practice activities. The amount of deliberate practice is certainly one key issue. Our study does not address this element directly as we do not know the practice schedule of the prodigies. However, it is well-known that music

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prodigies, and also prodigies in other fields, practice a lot more than ordinary students (McPherson, 1993). Actually, they may get very close to the 10,000 hours rule that makes a performer an expert (Ericsson et al., 2007). A 4-year-old who practices deliberately for 3–4 hours a day for 6 years will accumulate 8,000 hours by the age of 10 and well over 10,000 by the age of 14. What is presently lacking is an explanation of why would such young children dedicate so much time and effort in music practice and what characterizes this practice that allows them to reach the highest standards in few years.

It is worth pointing out that the present study focuses on piano performance, while there are many other musical areas in which prodigies may excel. For instance, prodigies like Mozart and Mendelssohn are known to have had phenomenal skills at a very young age in auditory memory, reading, improvisation and composition. Little is known about the emergence and expression of these skills in today's prodigies. Since modern prodigies seem to play much more complex pieces (Lehmann & Ericsson, 1998), one may wonder if this remarkable performance ability is developed at the expense of other skills.

To conclude, we have presented here empirical evidence for two criteria defining musical prodigy: level of performance and rate of progress. Our results enable us to propose an operational definition of a music prodigy: a child of 14 years old or less who performs well enough to be judged in terms of the most demanding criteria for performance in the field and whose rate of progress, estimated at two grades a year, is clearly distinct from that of ordinary music students.

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Figure Legends

Figure 1. Evaluation form appearing on the computer screen for each trial. The comments section was optional.

Figure 2. Percentage of correct responses in the identification and comparison tasks. Error bars indicate standard error; *** $p < .001$.

Figure 3. (a) Percentage of correct identification and (b) Mean rating of difficulty as a function of the age of the prodigies. Error bars indicate standard error; ** $p < .01$.

Figure 4. (a) Percentage of correct responses and (b) Mean rating of difficulty as a function of the age of the prodigies in the comparison task. Error bars indicate 95% standard error; ** $p < .01$, *** $p < .001$.

Figure 5. Percentage of correct identification as a function of the grade level of the piece. Linear regression shows an effect of grade level in the identification of prodigies in musicians' (adjusted $R^2 = 0.35$) but not in non-musicians' judgments (adjusted $R^2 = 0.09$). Error bars indicate standard error.

Figure 6. Mean sensitivity expressed as a d-prime value, as a function of the age of the prodigies. Error bars indicate standard error; *** $p < .001$.

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Figure 1

Audio clip	Who was playing the piece? Circle either Child or Professional	How difficult was it to decide who was playing the piece? Circle answer: 1 (very easy) to 5 (very difficult)	Comments
1	Child Professional	1 2 3 4 5	

Figure 2

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Figure 3

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Figure 5

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Appendix A.

590 List of stimuli taken from YouTube; C refers to a Child prodigy and A to an Adult professional

Composer	Piece	Performer (A/C)
C.P.E. Bach	Solfeggietto	Bear (C) / Bernachon (A)
J. S. Bach	French Suite No. 5 in G major, BWV 816, Courante	Qyunqyun (C) / Schiff (A)
	French Suite No. 6 Polonaise	Garrett (C) / Gould (A)
	Invention No. 13 in A minor, BWV 784	Liu (C) / Schiff (A)
Bartok	Romanian Folk Dances, No. 1	Qyunqyun (C) / Grimaud (A)
Beethoven	Piano Concerto No. 3 in c minor, Op. 37, 2nd mvt.	George (C) / Ashkenazy (A)
	Sonata in C major, Op. 2, No. 3, 1 st mvt.	Zhou (C) / Schnabel (A)
	Sonata in C major, Op. 2, No. 3, 2 nd mvt.	Zhou (C) / Arrau (A)
	Sonata in C major, Op. 53, "Waldstein" 1 st mvt.	Kobayashi, Poon, Qyunqyun (C) / Arrau, Lupu, Ott (A)
	Sonata in C minor, Op. 27, No. 2, 2 nd mvt.	Garrett (C) / Kempff (A)
	Sonata in C sharp minor, Op. 27 No. 2, 3 rd mvt.	Garrett (C) / Lisitsa (A)
	Sonata in C sharp minor, Op. 27, No. 2, "Moonlight", 1st mvt.	Li (C) / Parker (A)
	Sonata in D minor, Op. 31, No. 2, "Tempest", 1st mvt.	Garrett (C) / Barenboim (A)
	Sonata in G major, Op. 14, No. 2, 1 st mvt.	Kobayashi (C) / Backhaus (A)
Chopin	Ballade (No. 1) in g minor, Op. 23	Zhou (C) / Lortie (A)
	Ballade (No. 2) in F major, Op. 38	Garrett (C) / Richter (A)
	Ballade in f minor, Op. 52 (No. 4)	Poon (C) / Avdeeva (A)
	Etude Op. 10, No. 5 "Black Key"	Garrett, Qyunqyun (C) / Lisitsa, Pollini (A)
	Etude Op. 10, No. 9	Zhou (C) / Rubinstein (A)
	Etude Op. 25, No. 12	Rizikov (C) / Berezovsky (A)
	Etude, Op. 10, No. 4	Wang (C) / Argerich (A)
	Fantasie-Impromptu in c sharp minor, Op. 66	Darwich, George, Poon (C) / Biret, Igoshina, Rubinstein (A)
	Impromptu No. 1 in A flat major, Op. 29	Kobayashi (C) / Trifonov (A)
	Nocturne in B flat minor, Op. 9, No. 1	Poon (C) / Rubinstein (A)
	Nocturne in C sharp minor, Op. posth.	Liu (C) / Feltsman (A)
	Nocturne in E minor, Op. 72, No. 1	Zhou (C) / Li (A)
	Scherzo (No. 2) in B flat minor, Op. 31	Kobayashi (C) / Freire (A)
	Waltz in C sharp minor, Op. 64, No. 2	Bear, Lisiecki, Rizikov (C) / Lipatti, Ohlsson, Rubinstein (A)
	Waltz in D flat major, Op. 64, No. 1, "Minute"	Garrett (C) / Lang (A)
	Waltz in E Minor, Op. posth.	Garrett, George (C) / Godowsky, Rubinstein (A)
Debussy	Arabesque No. 2	Kobayashi (C) / Ciccolini (A)
	Children's Corner Suite: Doctor Gradus Ad Parnassum	Bouchard (C) / Michelangeli (A)
	Children's Corner: Golliwogg's Cakewalk	Garrett, Rizikov (C) / Berman, Debussy (A)
	La fille aux cheveux de lin	Zhou, Medel (C) / Giesecking, Michelangeli (A)
	Préludes, 2: General Lavine-eccentric (No. 6)	Qyunqyun (C) / Michelangeli (A)
	Suite bergamasque: Clair de lune	Poon (C) / Hewitt (A)
	Suite bergamasque: Menuet	Qyunqyun (C) / Francois (A)

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Gershwin	Prelude No. 1	Bear (C) / Zimmerman (A)
Grieg	Piano Concerto in a minor, Op. 16, 1 st mvt.	Lee (C) / Tomsic (A)
Haydn	Keyboard Concerto in D major, Hob XVIII:11	Levanov (C) / Richter (A)
Kapustin	Variations, Op. 41	Rizikov (C) / Kapustin (A)
Liszt	Liebestraum No. 3	George (C) / Horowitz (A)
	Trois etudes de concert No. 3 "Un Sospiro"	Lisiecki, Zhou (C) / Cliburn, Hamelin (A)
	Waldesrauschen	Garrett (C) / Hamelin (A)
Mendelssohn	Andante and Rondo capriccioso, Op. 14	Medel (C) / Cziffra (A)
	Piano Concerto No. 1 in g minor, Op. 25, 1 st mvt.	George (C) / Pletnev (A)
	Variations Serieuses Op. 54	Zhou (C) / Brendel (A)
Mozart	Piano Concerto No. 23, K 488	Bear (C) / Perahia (A)
	Piano Concerto No. 26 in D major, K 537, 1 st mvt.	Kobayashi (C) / Ashkenazy (A)
	Sonata in B flat major, K 333, 3 rd mvt.	Qyunqyun (C) / Horowitz (A)
	Sonata in C major, K 545, 2 nd mvt.	Liu (C) / Uchida (A)
	Sonata in C major, K 545, 3 rd mvt.	Liu (C) / Eschenbach (A)
	Sonata in F major, K 332, 3 rd mvt.	Zhou (C) / Uchida (A)
	Twelve Variations on "Ah vous dirai-je Maman" K 265	Yoon (C) / Eschenbach (A)
Prokofiev	Piano Sonata Op. 28, No. 3	Zhou (C) / Gilels (A)
	Toccata in d minor, Op. 11	Poon (C) / Argerich (A)
Ravel	Jeux d'eau	Poon (C) / Février (A)
	Sonatine 3 rd mvt.	Garrett (C) / Tharaud (A)
Schubert	Impromptu in E flat major, Op. 90 (No. 2)	Bouchard, Kobayashi (C) / Brendel, Pires (A)
Schumann	Arabeske in C major, Op. 18	Poon (C) / Sokolov (A)
	Piano Concerto in a minor, Op. 54, 1 st mvt.	Bear, Garrett (C) / Argerich, Kissin (A)