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Early music experiences and IQ: Identification of a "Gifted Learning Pathway"

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Abstract

In the Actiotope Model of Giftedness, the main aim of gifted identification is to determine learning pathways that ultimately lead to excellence. The model takes a dynamic perspective and is interested how the interplay of resources and their goal-directed synchronization produce talent development. According to the findings of research on expertise, the early stages of a learning pathway are characterized by playful encounters with a domain, but also by rapid learning progress and thus frequent successes. This theoretically allows for two different synchronized learning pathways, which we refer to as "Playful Begin – Performance-oriented Continuation" and "Easy Begin – Playful Continuation". We examined both learning pathways in a longitudinal study with preschoolers. The data were consistent with "Easy Begin – Playful Continuation". In the early stage, aligned learning resources that provide easy experiences of success, and in the second stage, learning resources that support a playful encounter with music were associated with a better individual action repertoire represented by IQ.

Keywords: Actiotope Model of Giftedness, learning resources, music, learning pathway, intelligence

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Introduction

In traditional approaches to the identification of giftedness, the focus was almost exclusively on individuals. In other words, the aim of such traditional approaches was to find and select those individuals who are gifted (Ziegler, Alghawi, & Reutlinger, 2018). However, during the past decades, the traditional approach has been challenged by two significant developments.

First, many conceptions of giftedness broadened to include environmental factors alongside individual factors (Sternberg & Davidson, 2005). The interest of educators and researchers, therefore, became to not only identify gifted individuals, but also to identify favorable environments. To this end various concepts were created, such as "gifted environments" (Mirman, 2003), "smart contexts" (Barab & Plucker, 2002), or "talent hotspots" (Coyle, 2009). These concepts derived from the insight that not only do individuals differ in their potential to attain extraordinary accomplishments, but also environments differ in their potential to offer learning opportunities that make extraordinary accomplishments possible.

Second, an increasing number of researchers questioned whether gifts and talents were stable characteristics of a person. Instead, they recommended that the focus shift to change, that is, to consider learning processes embedded in stimulating environments (Dweck, 1999; Ericsson, Charness, Feltovich, & Hoffman, 2006). Ziegler and Phillipson (2012) suggested the concept of a learning pathway, which they defined as an ordered sequence of learning episodes spanning from beginner to expert level. From this perspective, the fundamental unit of analysis of gifted identification is neither the individual nor the environment, but rather a successful sequence of learning episodes during which an individual makes optimal use of the learning opportunities in their personal learning environment (Ziegler, 2005).

Learning pathways can be identified on an individual level as well as on an inter-individual level, reflecting generally promising sequences of learning episodes. In the current research, we focus on the inter-individual level and the identification of a learning pathway that examines early musical development and its effect on general cognitive development as represented by IQ.

Learning pathways can be analyzed at different levels of resolution, ranging from micro processes that may encompass just a few moments, to macro processes that may span several years. An example of the latter is the observation by Ericsson, Krame, and Tesch-Römer (1993) that the development of excellence occurs through three phases. The first phase is a playful one in which individuals encounter a domain for the first time. After some time in the playful phase, their talent may be recognized by their parents or teachers and organized learning processes are introduced at this second phase. It is only after years of extensive deliberate practice that excellence may be attained. In the current research we focus on the early stages of talent development.

Theoretical background

Our theoretical framework is the Educational and Learning Capital Approach (ELCA) (Ziegler & Baker, 2013; Ziegler, Chandler, Vialle, & Stoeger, 2017), which was devel-

oped within the systemic paradigm of the Actiotope Model of Giftedness (Ziegler & Stoeger, 2017). This model posits that the unit of analysis of gifted identification is not the gifted individual, but rather the entirety consisting of the individual and their material, social, and informational environments. Such an individual lifeworld or 'actiotope' (Ziegler, Vialle, & Wimmer, 2013) is constituted through the actions of the individual.

Systems need a constant influx of resources for self-regulation in order to maintain stable internal conditions and to function within a normal range. This type of balance is called homeostasis (from the Greek "homo" for "similar" and "stasis" for "standing still") and describes the process by which a system returns to a particular state. However, the main objective of gifted education is in many respects not just to maintain homeostasis, but rather to challenge it and then re-establish it at a different (skill) level. Technically speaking, in contrast to homeostasis, homeorhesis is the process by which a dynamic system returns to a trajectory. To make this dynamic work, gifted individuals need resources (see Ziegler et al., 2017).

ELCA distinguishes five types of exogenous learning resources that are located outside the individual, which we have termed educational capital. Complementing these exogenous resources are five types of endogenous learning resources that are located within the individual, and which we have termed learning capital (for definitions, see Table 1). Although these learning resources are regarded as conceptually distinct, in reality they are inherently interlinked and overlap. For example, parents are a form of social educational capital, but they also transmit cultural educational capital. Similarly, as competent educators of their children, they also represent didactic educational capital.

ECLA assumes that a learning pathway is a co-evolutionary homeorhetic process involving corresponding changes in learning resources. The synchronization of learning resources is therefore of paramount importance for successful learning processes. While a person is on a learning pathway towards excellence, they acquire the ability to perform highly effective actions (see Ziegler & Stoeger, 2017). Thus, the central outcome variable of talent development is actional learning capital comprising not only overt behavior, but also internal actions such as perception, thinking, and retrieval of information.

In our research, we were interested in how music-related learning resources might influence the development of a gifted learning pathway. Previous research has found associations between musical experiences and improvements in higher-level cognitive functions such as IQ, reading, verbal and perceptual abilities (e.g., Degé, Kubicek, & Schwarzer, 2011; Dumont, Syurina, Feron, & van Hooren, 2017; Ho, Cheung, & Chan, 2003; Kaviani, Mirbaha, Pournaseh, & Sagan, 2014; Moreno et al., 2011; Portowitz, Lichtenstein, Egorova, & Brand, 2009; Roden et al., 2014; Rodrigues, Loureiro, & Caramelli, 2013; Schellenberg, 2006; Tsang & Conrad, 2011). However, the research findings are far from conclusive and in several studies, the researchers failed to establish a reliable association (e.g., Costa-Giomi, 1999; Moreno et al., 2009). A recent meta-analysis has called into question whether there are any transfer effects to general cognitive abilities, pointing out that the better controlled the studies, the weaker the effect sizes (Sala & Gobet, 2017).

Table 1:
Definitions of the Various Types of Educational and Learning Capital according to Baker & Ziegler (2013)

Exogenous Resources	
Type	Definition
Economic educational capital	Economic educational capital denotes every kind of wealth, possession, money, or valuable that can be invested in the initiation and maintenance of educational and learning processes. (p. 27)
Cultural educational capital	Cultural educational capital denotes value systems, thinking patterns, models, and the like that can facilitate – or hinder – the attainment of learning and educational goals. (p. 27)
Social educational capital	Social educational capital denotes all persons and social institutions that can directly or indirectly contribute to the success of learning and educational processes. (p. 28)
Infrastructural educational capital	Infrastructural educational capital denotes materially implemented possibilities for action that allow learning and education to take place. (p. 28)
Didactic educational capital	Didactic educational capital denotes the assembled know-how involved in the design and improvement of educational and learning processes. (p. 29)
Endogenous Resources	
Organismic learning capital	Organismic learning capital denotes the physiological and constitutional resources of a person. (p. 29)
Telic learning capital	Telic learning capital denotes the totality of a person's anticipated goal states that offer possibilities for satisfying her needs. (p. 30)
Actional learning capital	Actional learning capital denotes the action repertoire of a person; as such, it describes the totality of actions a person is capable of performing. (p. 30)
Episodic learning capital	Episodic learning capital denotes the simultaneous goal-relevant and situation-relevant action patterns that are accessible to a person. (p. 31)
Attentional learning capital	Attentional learning capital denotes the quantitative and qualitative attentional resources that a person can apply to learning. (p. 31)

One possible explanation for these contradictory research outcomes is that the association between musical experiences and higher-level cognitive functions is moderated by further variables such as SES, musical content, and executive functions (Holochwost et al., 2017). However, the results here, too, have been mixed (e.g., Degé, Kubicek, & Schwarzer, 2011; Jaschke, Honing, & Scherder, 2018). In the current research, we pursued a different moderation hypothesis regarding the role of aligned exogenous learning resources at different phases of early musical experiences.

The exogenous learning resources we focused on included, firstly, parental goal orientations. Parents are a form of social educational capital and their goal orientations provide cultural educational capital (see Table 1). Following Gibson's concept of affordances (Gibson, 1979; Heft, 1997; Hinton, 2014), we focused secondly on children's play with musical toys. Affordances in general can be defined as opportunities for actions available in the environment and, in particular for musical toys, as opportunities for musical play. Thus, musical toys' innate characteristics trigger certain ways of playing and thus provide distinctive learning opportunities. Musical toys are therefore not only infrastructural educational capital, but also didactic educational capital as they invite children to expand their action repertoire and build actional learning capital (see Table 1).

Overview of current research

Parents generally take care in deciding what kinds of toys to provide to their children (Pierce, 2000). An advantage of musical toys is that while parents may not find time to directly engage with their children in making music (de Vries, 2009), toys offer an option to integrate music into the child's daily play. Many musical toys enable toddlers to engage in music without the need for special skills. This is often referred to as baby-directed music (Sulkin & Brodsky, 2015) and targets several aspects of child development including sensory-motor, language, communication, emotional, social, and cognitive modalities (Bower, 2010; de l'Etoile, 2006; Ilari, 2005). Thus, in line with the aforementioned research we anticipated transfer effects to higher-level cognitive functions. As a measure of higher-level cognitive functions, we focused in our research on IQ[4].

Various types of musical toys are available for young children's play. Based on the Affordances in the Home Environment for Motor Development-Infant Scale (AHEMD; Bradley et al., 1989; Caldwell & Bradley, 1984) we proposed a division of musical toys into two categories based on whether their affordances invite a playful or a performance-oriented approach to musical play. Those included in the category of playful toys include musical toys that offer an easy way for children to play complete songs, rhythm sequences, or melody sequences by just pushing a button or performing another simple function. Thus, this type of toy is characterized by the low level of difficulty inherent in the product's handling. The performance-oriented category encompasses musical instruments,

[4] From the perspective of ELCA the results of IQ tests reflect how much an individual is immersed in the cultural tools necessary to solve its items (cf. Richardson, 2002), hereby representing actional learning capital (see Ziegler, Debatin, & Stoeger, 2019).

which are based on real instruments but simplified in their usage. Examples are simplified versions of horns, drums, guitars, xylophones, and pianos. The next category after these modified instrumental toys would be real music instruments.

We assumed that parental goal orientation affects the way they set up the playing environment for their children and the affordances of musical and instrumental toys to which they direct the attention of their children. In our research, we considered three goal orientations of parents: a learning goal orientation, a performance goal orientation, and a play goal orientation. Parents who subscribe to a play goal orientation want their children to acquire age-appropriate playful experiences. Parents who subscribe to a learning goal orientation focus on their children's understanding, learning, and improvement of their skills rather than with external indicators of achievement (Ablard & Parker, 1997). In contrast, parents who hold a performance goal orientation are concerned with the validation of their child's competence via external indicators of good performance. However, a performance orientation is a double-edged sword. On the one hand, these parents focus on high performance because, to them, it signifies competence and high intelligence (Ablard & Parker, 1997). On the other hand, easy successes are most informative (Dweck, 1999).

From the point of view of the synchronization of learning resources, two different learning pathways are conceivable. We term them "Playful Begin – Performance-oriented Continuation" and "Easy Begin – Playful Continuation". They span from first experiences with music to an increase in general cognitive abilities, i.e. actional learning capital. From a learning point of view, both learning pathways assume equally that actional learning capital must be built up successively and progressively. This means that first the learning has to take place in interaction with the less demanding affordances of the instrumental toys and only then with the more complex affordances of the musical instruments.

Two of the parental motivational orientations can lead to a start with the music as it is described in expertise research. Both a play goal orientation and a performance goal orientation that is primarily directed towards quick success directs the attention of the children first to the affordances of the simpler musical toys. However, it would be necessary to change both motivational orientations when switching to the more complex affordances of musical instruments. A play goal motivational orientation would not be synchronized with the increased learning requirements of instrumental toys. Then either a learning goal orientation or a performance goal orientation would have to draw attention to these new affordances. However, a performance goal orientation that is geared towards easy success experiences would also soon reach its limits if the learning demands were to grow as a result of the changed affordances of musical instruments. Learning progress is then slower and failures can occur. In this case, it would be better if parents switch to a play goal orientation in order to buffer the failures. In summary, we would like to state that two learning paths seem theoretically possible, a "Playful Begin – Performance-oriented Continuation" and an "Easy Begin – Playful Continuation". In a study with preschool children we will examine whether evidence for one or even both can be found.

Method

Participants

A total of 203 German kindergarten children and their parents took part in this study. The average age of the 111 girls and 92 boys was M=4.5 years, SD=0.50. The parental questionnaire was filled out for each child by at least one parent. For 146 children, the questionnaire was completed by the mother, for 27 children by the father, and for 30 children by both parents.

Measures

Intelligence quotient. IQ was measured at the first and second measuring point with the German version of the 3rd edition of the Wechsler Preschool and Primary Scale of Intelligence (Petermann & Lipsus, 2009) which is based on the WPPSI-III (Wechsler, 2002). The children were tested twice in an interval of 6 months. The German Version of the WPPSI-III is considered a reliable (α=.95) and valid test (Petermann & Lipsus, 2009).

Musical and instrumental toys. The Affordances in the Home Environment for Motor Development-Infant Scale (AHEMD) (Bradley et al., 1989; Caldwell & Bradley, 1984) is a reliable and valid parental self-report assessment that addresses the quality and quantity of factors in the home that are conducive to the development of children, especially their motor development (Gabbard, Caçola, & Rodrigues, 2008; Rodrigues, Saraiva, & Gabbard, 2005). It is widely used and has been translated from English into several languages including German, Arabic, Chinese, Dutch, French, and Portuguese (cf. Valadi, Gabbard, Arabameri, Kashi, & Ghasemi, 2018). For measuring the number of musical and instrumental toys, we only used the items of the AHEMD that related to music toys.

Parental goal orientations. Performance and learning goal orientation were measured with the Nuremberg Parental Goal Orientation Scales (Reutlinger, Ballmann, Vialle, Zhang, & Ziegler, 2015). These scales comprise seven items with a 5-point Likert scale answer scheme for each goal orientation (performance goal orientation: α=.95; learning goal orientation: α=.94). To measure the play goal orientation of the parents, we developed a 5-point Likert scale that was analogous in structure to the performance and learning goal orientation scales. It also comprises seven items (sample item: *It's important for me that my child plays nicely*). The scale proved to be sufficiently homogeneous as indicated by a Cronbach's alpha of α=.89.[5]

[5] For validation purposes, we calculated Pearson correlations between the play goal orientation and those items of the AHEMD that could plausibly be connected with a play orientation scale. We assumed that parents with a play goal orientation would also try to offer their child an environmental setting, which enabled the child to play easily. This included an easy reachable playground (r=.260), an easy reachable area for sport (r=.260), ample space for the child to play (r=.260), that the child has an own room/playroom (r=.260), and a special place for toys that is easily accessible to the child (r=.260). Though the correlations were only weak to moderate, they were all statistically significant ($p < 0.05$) and in the expected direction.

Data collection

Measurements were administered by trained personnel. IQ was measured twice at six-month intervals. The number of musical and instrumental toys as well as the parental goal orientations were measured at measurement point 1 only.

Data analysis

Confirmatory Factor Analysis (CFA) was conducted to measure the influence of musical toys, musical instruments, parental play goal orientation, parental learning goal orientation and parental performance goal orientation on the development of the general IQ. Therefore the software R 3.5.0 with the library lavaan 0.6-1 (Rosseel, 2012; Rosseel et al., 2018) was used. The lavaan library offers several methods to fit a latent or manifest variable model. The CFA was estimated with Maximum Likelihood (ML) and, for the proof of the goodness of the model, Chi-square Fit Statistics, Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI), and Tucker-Lewis Index (TLI) were used. Small and non-significant Chi-square indicates a good fit. RMSEA incorporates a penalty function for poor model parsimony. Values equal to or below .08 suggest close approximate fit (Hu & Bentler, 1999). CFI and TLI represent incremental fit indices contrasting the hypothesized model to a more restricted nested baseline model. Both values above .90 indicate good fit (Kline, 2005).

Results

Descriptive statistics

Table 1 contains means and standard deviations. Interestingly, we found an increase in general IQ. One explanation could be that our sample is special in that all the children attended kindergarten and thus enjoyed a special education (see BMFSFJ, 2018).

Table 2 shows the correlations among parents' goal orientation, different types of toys, IQ and IQ growth. Interestingly, play goal orientation and performance goal orientation were negatively related.

Path analysis

We specified a model, which included IQ, IQ increase, the number of musical toys and musical instrument, parents' play goal orientation, parents' learning goal orientation and parents' performance goal orientation. The basic idea was that aligned learning resources influence general IQ and general IQ development. Specifically, it was assumed that the influence of parents' play goal orientation on IQ is mediated by the number of musical toys. Furthermore, it was assumed that the influence of either parental learning goal orientation or performance goal orientation on IQ growth is mediated by the number of

Table 2:
Descriptive statistics for used scales and items

Variables and Scales used for the model	*M*	*SD*	*Cronbach's alpha*
Play orientation	3.84	0.86	0.89
Performance goal orientation	3.28	1.13	0.95
Learning goal orientation	3.50	1.09	0.94
Musical toys	3.48	2.27	
Musical instruments	4.15	1.94	
IQ (measuring point 1)	97.26	13.74	
IQ increase between measuring point 1 and measuring point 2	4.01	5.49	

Table 3:
Correlations

	Performance goal orientation	Learning goal orientation	Musical toys	Musical instruments	IQ (measuring point 1)	IQ growth
Play goal orientation	-.219**	-.165*	-.261**	.190**	-.064	-.056
Performance goal orientation		-.340**	.331**	-.164*	.017	-.112
Learning goal orientation			-.152*	-.063	-.006	.054
Musical toys				.130	.145*	.051
Musical Instruments					-.088	.137*
IQ						-.145*

Note. * = $p < 0.05$, ** = $p < 0.01$ (2-tailed)

musical instruments. In line with these assumptions, we built a model including the paths between the parental goal orientations and both toy types. Based on the correlation we excluded the paths between the toys and the parental learning goal orientation.

As shown in Figure 1 and Table 4, this model showed very good fit indices with CFI and TLI above .90 as well as RMSEA and SRMR below .08. All path coefficients were significant at the .05 level or below except the path coefficients to IQ growth, which were marginally significant at the .10 level. The results show that parents' performance goal

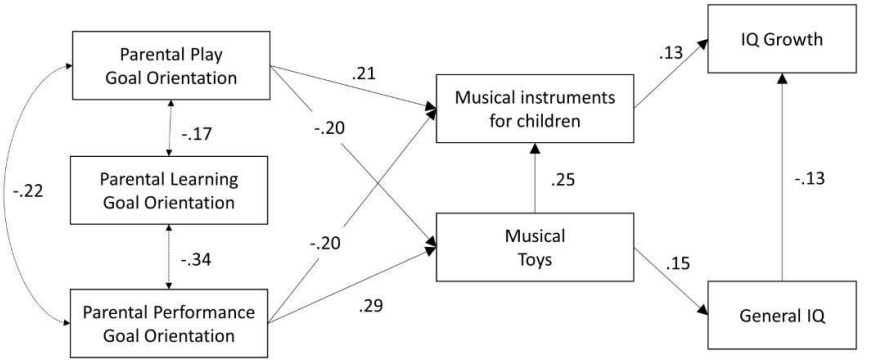

Figure 1:
The path model

Table 4:
Fit indices of the path model

χ^2	df	χ^2/df	P value (chi-square)	CFI	TLI	RMSEA	SRMR
10.502	10	1.050	0.398	0.995	0.990	0.016	0.038

orientation had a positive influence on the number of musical toys and a negative influence on the number of instrumental toys. Parents' play goal orientation had the assumed reverse influence on these two toy categories, that is, a negative influence on the number of musical toys and a positive influence on the number of musical instruments. It is worth noting that, in this path model, parents' learning goal orientation did not have any influence on the number of musical or instrumental toys. In line with our assumptions, the number of musical toys was positively associated with general IQ, and the number of instrumental toys with IQ growth.

Discussion

Traditionally gifted identification focused on the traits of individuals. However, more recently it has become evident that this kind of identification does not go far enough. If giftedness implies that someone can achieve excellence (Ziegler, 2005), then we must also consider whether this goal can be achieved through learning. The identification of gifted learning pathways, or promising sequences of learning episodes that lead to excellence, should therefore become an independent goal of gifted identification.

In this paper we focused on the transfer effects of early musical experiences from the perspective of ELCA. In line with the findings of expertise research, we considered two different learning pathways conceivable (Ericsson, 2008): A learning pathway that is initially playful and subsequently geared to performance and a learning pathway that is initially geared to easy success experiences and subsequently a playful encounter with more demanding learning material. Our study goes beyond previous expertise studies in that we did not consider the effects on the development of musical abilities, but a possible transfer to general cognitive abilities. Thus, our current study reflects studies, which on the one hand assume the effects of musical experiences on general cognitive abilities, but on the other hand assume moderator effects (Holochwost et al., 2017).

Playful and performance-oriented early musical experiences were operationalized through the provision and alignment of exogenous learning resources. Specifically, it was assumed that parents' goal orientations direct their children to the toys' inherent affordances, thus encouraging their children to specific musical experiences. Instrumental toys provide more complex cognitive experiences including the possibility for children to create their own music, whereas musical toys are more simple in their affordances and thus better suited for first musical experiences (e.g., Husain, Thompson, & Schellenberg, 2002; Yang, McClelland, & Furnham, 2016). Indeed, the data showed that musical toys allow early transfer effects to general cognitive abilities, whereas musical instruments allow for subsequent increases in general cognitive abilities.

Interestingly, in the path analysis we found no direct influence from the three different goal orientations of the parents on the general IQ of their children. However, different goal orientations of the parents was associated with them providing different toys. In accordance with our moderation hypothesis, aligned exogenous learning resources predicted IQ and, in a subsequent phase, increases in IQ. The results favored the learning pathway we had termed "Easy Begin – Playful Continuation".

From the point of view of gifted identification, there are three important implications of our study. Firstly, a gifted learning pathway could be identified in relation to children's first musical experiences. In brief, parents should in a first stage provide children with easy successes. This must be reflected in their own performance goal orientation, which is geared to easy successes of their children. Thus, they first encourage their children to play with simple musical toys. However, if they want to further enact the transfer potential of early musical experiences to general cognitive abilities, they must change their own goal orientation to focus more on children´s playful engagement. Though they need to provide their children with more challenging instrumental toys that enable learning progress.

The current study suggests that a focus on learning resources enriches traditional gifted identification approaches (see also Ziegler et al., 2019). In the reported study, two exogenous learning resources were measured directly (parental goal orientations and musical toys). However, it would be useful to develop screening instruments that better measure the overall impact of learning resources.

A third important implication is that our study points to the value of a systemic approach to giftedness. In the systemic Actiotope Model of Giftedness, the unit of analysis is no

longer on the gifted individual, but rather the entire system consisting of the individual and their social, material, and informational environment (Ziegler et al., 2013). This is reflected in our study in the involvement of parents (social), musical toys (material) and the affordances of the musical toys (informational).

There are some limitations of our study. From a theoretical perspective, while we have established a moderation hypothesis, it does not provide information about the exact cognitive mechanisms involved. Therefore, the precise ways in which children's engagement with musical toys leads to increases in IQ remains open. One mechanism frequently cited in the literature could be executive functions (Holochwost et al., 2017). However, this is not the resolution level at which the explanation would be sought in the Actiotope Model of Giftedness. In this model, a much more laborious mechanism to be uncovered would be overlaps in the action repertoire, that is, the action repertoires overlap when dealing with musical toys, musical instruments and solving the items in the IQ test.

A second limitation of our study is that learning pathways can be identified on an individual level as well as on an inter-individual level, the latter reflecting generally promising sequences of learning episodes. In this article, we focused on the inter-individual level. Thus, before non-ergodicity is confirmed, the findings cannot be simply transferred to individual learning pathways.

Several researchers (e.g. Jaschke et al., 2018; Sala & Bobet, 2017) have stressed that the study of the transfer of musical skills to general cognitive abilities requires randomized longitudinal studies. However, this poses a problem that is germane to all studies on gifted identification (for a summary see Gruber, Weber, & Ziegler, 1996). Prospective longitudinal studies with gifted individuals would require, on the one hand, that the gifted individuals be known in advance. Since this is not the case and almost all children have some kind of music toy early in life, an entire cohort would have to be covered. The only alternative apart from studies like ours, are retrospective interviews or historiometric analyses (Simonton, 2019).

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