Possible Connection between the Development of Executive Functions and Music Education According to the Kodály Concept

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Abstract

This research will focus on comparing tasks that are used to measure the development of executive functions (EFs) and musicianship exercises according to the Kodály concept in order to find analogies and functional intersections between them. EFs are essential for our mental and physical health, for school and job success. Since these skills can be improved and early EFs training might help reduce social disparities in academic achievement and health, pinpointing activities that could develop EFs has become an important research topic in psychology, neuroscience, and education in recent years.

The main direction of this research will be a close examination of the tasks used for measuring the three core components of EFs - inhibition, cognitive flexibility and working memory alongside musicianship exercises taken from Kodály methodological books and lesson observations that work in a similar way.

This study has found similarities between EF tasks and Kodály musicianship exercises in all the three core components of EFs. These findings could indicate that with Kodály's music education approach we are not only practising musicianship exercises but we might challenge our EF skills as well. This research, therefore, could be a first step that leads to a more complex investigation into the potential positive impact of music education according to the Kodály Concept on EFs.

Contents

1. Introduction

In an orchestra, the musicians play their parts perfectly, but the conductor has a critical role, i.e., to harmonise these different instruments into a perfect whole and help the musicians work together. In our brains, this conductor is called the executive functions (Brown, 2006) – that is, a set of cognitive skills that "enable a person to engage successfully in independent, purposive, self-serving behaviour" (Lezak, 1995, p.35)

These skills are "critical for school and job success and for mental and physical health" (Diamond, 2013) and since EFs are trainable (Diamond, 2012), there is interest to find out what programs and strategies could improve EFs (Diamond and Ling, 2016).

Although existing research indicates that trained musicians have better EF skills (Bialystock & DePape, 2009; Diamond and Ling, 2016; Travis et al., 2011), the positive relationship between music education and EFs is not always found in such investigations (Schellenberg, 2011a). This may be due to the fact that different music programs require different tools and skills, therefore they possibly could lead to different achievements.

Because of this ambiguity, I chose to examine music education according to the Kodály concept which is a complex music program that is highly interactive and involves singing, instrument playing, movements, games, group, and individual activities, composition, and improvisation. Moreover each musical element is grounded in sensorimotor activity and reinforced by a series of aural, visual and kinaesthetic stimuli (Kokas, 1972). It is also important that the aim of this concept is to make music education accessible to everyone and teaches music in an intuitive and exploring way from the early ages.

This research focuses specifically on music education according to the Kodály concept in connection with the components of EFs frequently highlighted by researchers, like working memory, inhibitory control, and cognitive flexibility. My research aims to explore a

possible connection between music education according to the Kodály concept and the development of EFs. While researching EFs, analogies emerged between the structure of the tasks used to measure the different components of EFs and the musicianship exercises according to the Kodály concept. There are many exercises that require similar skills as some tasks that measure the development of certain EF components. For instance, tasks that measure inhibition and certain Kodály exercises both require inhibiting the dominant response in order to complete the tasks. In other exercises students have to adapt quickly to changing rules, as in tasks that assess cognitive flexibility, and like in working memory tasks, in many Kodály exercises it is necessary to keep information in mind and manipulate it.

My investigation will examine EFs tasks one by one alongside the corresponding tasks taken from Kodály methodological books and lesson observations from The Royal Conservatoire of the Hague and from Junior Guildhall, London. My goal is finding out whether there are analogies or functional intersections.

The main question I aim to answer is this: are there analogies or functional intersections between the tasks used to measure the development of executive functions and the tasks used to teach music according to the Kodály concept? To answer it, these questions must also be explored:

- Can analogies be found in every component of EFs?
- In which components of EFs can analogies be found?
- Are there any indications that further research could prove music education according to the Kodály concept has a positive impact on the development of EFs based on the analogies discovered?

My hypothesis is that if most of the EF tasks can be covered with Kodály exercises, it could mean that while we learn music according to the Kodály concept, we are not only practising musicianship exercises but we might challenge our EF skills as well.

With this research I would like to raise awareness of other professionals in music education and psychology that there might be another area of music education that is worth researching in connection with EFs. This research is a first step that leads to a more complex investigation into the potential positive impact of education according to the Kodály Concept on EFs. Since those who need improvement the most, including disadvantaged children benefit the most from EF programs, early EF training could be an effective way of reducing social inequalities in EFs development and therefore social disparities in school readiness, academic achievements and health (Diamond, 2012). It is important to find more activities or programs for improving EF skills that are available and easily incorporated into school curriculum.

2. Literature Review

2.1. Executive Functions

Executive Functions EFs (executive control or cognitive control) are a group of cognitive skills predominantly located in the prefrontal cortex. They enable us to concentrate, keep goals in mind, inhibit irrelevant information, think before we act, resist temptation and distraction, tolerate frustration, consider the consequences of our behaviour, reflect on past experiences, and plan for the future accordingly and to flexibly adjust to changing circumstances. (Diamond, 2013; Zelazo et al., 2016).

EFs have three core components. Inhibitory control makes it possible to choose how we react. It involves controlling our behaviour and preventing us from acting impulsively.

Cognitive flexibility is often associated with creativity; it helps us to adjust to changed circumstances, to look at the same thing in different perspectives, and to "think outside the box," (Diamond and Ling, 2016). Working memory enables us to hold information in mind and manipulate it at the same time. (Janacsek et al., 2009).

EFs can also be distinguished between hot and cold EFs (Zelazo and Müller, 2002). While hot EFs are responsible for motivation and emotion regulation e.g. managing anxiety, sadness, or anger, (Zelazo and Cunningham, 2007), cold EFs include processes that require explicit cognitive skills. For instance, poor hot EF is associated with behaviour problems in preschoolers, while cold EF is responsible for academic outcomes including maths and reading (Zelazo et al., 2016).

The role of EF is important from early childhood through lifespan. The development of EFs often predicts school readiness, health, wealth, and quality of life more accurately than IQ or socioeconomic status (Moffitt et al., 2011). Its functioning plays a role in school and work success, physical and mental health, cognitive, social, and psychological development - thus, in better life management and quality of life (Diamond, 2013; Zelazo et al., 2016).

EFs are crucial in every aspect of life and also important for society (see Figure 1). For instance, people with better EFs are less likely to commit crimes or engage in substance abuse (Moffitt et al., 2011). Hungarian psychiatrist Éva Gyarmathy states that EFs are the skills that hold our civilization together (Haász, 2021).

Figure 1

Executive functions importance in every aspect of life

Aspects of life	The ways in which EFs are relevant to that aspect of life	References
Mental health	EFs are impaired in many mental disorders, including:	
	- Addictions	Baler & Volkow 2006
	- Attention deficit hyperactivity (ADHD)	Diamond 2005, Lui & Tannock 2007
	- Conduct disorder	Fairchild et al. 2009
	- Depression	Taylor-Tavares et al. 2007
	- Obsessive compulsive disorder (OCD)	Penadés et al. 2007
	- Schizophrenia	Barch 2005
Physical health	Poorer EFs are associated with obesity, overeating, substance abuse, and poor treatment adherence	Crescioni et al. 2011, Miller et al. 2011, Riggs et al. 2010
Quality of life	People with better EFs enjoy a better quality of life	Brown & Landgraf 2010, Davis et al. 2010
School readiness	EFs are more important for school readiness than are IQ or entry-level reading or maths	Blair & Razza 2007, Morrison et al. 2010
School success	EFs predict both maths and reading competence throughout the school years	Borella et al. 2010, Duncan et al. 2007, Gathercole et al. 2004
Job success	Poor EFs lead to poor productivity and difficulty finding and keeping a job	Bailey 2007
Marital harmony	A partner with poor EFs can be more difficult to get along with, less dependable, and/or more likely to act on impulse	Eakin et al. 2004
Marital harmony	A partner with poor EFs can be more difficult to get along with, less dependable, and/or more likely to act on impulse	Eakin et al. 2004
Public safety	Poor EFs lead to social problems (including crime, reckless behavior, violence, and emotional outbursts)	Broidy et al. 2003, Denson et al. 2011

Note. Adapted From "Executive Functions" by Adele Diamond, 2013. https://doi.org/10.1146/annurev-psych-113011-14375

2.1.1. Executive Functions in Childhood

EFs are critical for school readiness, school success and for mental and physical health (Diamond, 2013). They predict both maths and reading competence throughout the school years (Duncan et al, 2007) as well as later academic performance (Raver et al., 2011). EFs make it possible for children to sit still longer, pay attention during the lessons, to remember and follow rules and to flexibly adopt new perspectives (Zelazo et al., 2016). They are also associated with self-regulated learning (Zimmerman, 2008).

Children who start school with better EF development learn more easily and effectively from the same amount of practice and instruction (Benson et al., 2013), which may result in positive effects such as enjoying school better, being more motivated, feeling more confident and having a better relationship with teachers. They are also likely to graduate from college by the age of 25 (Zelazo et al., 2016).

Beside academic outcomes, EF skills are also important for social behaviour and emotion regulation (Zelazo et al., 2016), and their development also predicts long-term physical and mental health (Moffitt et al., 2011). A study found that children with better inhibitory control grew up to be happier adults. They had better physical and mental health, were in a better financial situation - and they were less likely to have broken the law 30 years later compared with those who had poorer inhibitory control as children (Moffitt et al., 2011).

Individual differences in EF skills can be related to temperament, genes, and different cognitive skills, but the development of EFs is primarily linked to the environment in which the child lives and grows up (Zelazo et al., 2016). Children growing up in disadvantaged environments or lower socioeconomic status have poorer EFs (Hackman & Farah, 2008). Insufficient parental care and stressful experiences at an early stage of life can also get in the way of EF development; extreme poverty is also associated with lower academic results because of its effects on EFs (Zelazo et al., 2016).

Poor EFs are often associated with learning difficulties and attention deficit hyperactivity disorder (Diamond, 2005). Kindergarten children with worse EF skills have more difficulty in reading and maths, and this gap could grow and persist throughout the school years (McClelland et al., 2006). Poor EF skills could also interfere with establishing good relationships with teachers or classmates (Diamond, 2014) as well as behaviour problems, lower academic outcomes, being held back, suspension, or school dropout (Zelazo et al., 2016). Children coming from lower socioeconomic status (SES) families are at a

further risk in classroom settings to receive a host of negative experiences that could lead them to negative self-esteem and lack of motivation. Studies have found that EF skills may play a critical role in the gap in academic achievement between children from lower vs. higher SES backgrounds (Zelazo et al., 2016).

2.1.2. Activities and Programs for improving Executive Functions

Executive functions can be improved and those who most need improvement benefit the most from intervention programs. Therefore early EF training might be an excellent way of reducing social inequalities in EF development and thereby social disparities in school readiness, academic achievements and health (Diamond, 2012).

EFs can be improved throughout lifespan; however preschool years and the transition to adolescence seem to be a promising time for interventions (Zelazo et al., 2016). High-quality educational experiences and direct and indirect training of EFs could have a positive impact on EFs development (Zelazo et al., 2016). Computer-based training e.g. Cogmed can improve working memory and reasoning in children; traditional martial arts, e.g. taekwondo, and two school curricula, Montessori and Tools of Mind, have also been proven to have a positive impact on EFs developments (Diamond, 2013). Although there is more research on direct EFs training, research concerning indirect approaches - for instance aerobics, yoga, exercise, mindfulness, and video games - suggests that indirect training could be highly effective (Zelazo et al., 2016). It is also possible that there are more activities not yet studied (e.g. theatre, orchestra, choir) that could also enhance EF skills (Diamond, 2012).

There are several programs that have been found to be effective for improving EF skills but these programs were primarily developed for early childhood (Zelazo et al., 2016) and it is still unclear whether the benefits of such EFs programs last and for how long, which activities have the most lasting benefits, which programmes help children the most at what

age, and who can profit the most from which activity (Diamond, 2012). However, there are general principles that seem to be important for every EFs program. EFs need to be regularly and progressively challenged. It is also important to keep the children's motivation (Zelazo et al., 2016) and provide programs that involve activities they love and address the children's emotional, social, physical and character development (Diamond, 2012).

2.1.3. Music Education and Executive Functions

Although existing research indicates that trained musicians have better EF skills (Bialystock & DePape, 2009; Diamond and Ling, 2016; Travis et al., 2011), the positive relationship between music education and EFs is not always found in such investigations (Schellenberg, 2011a). A systematic review by Rodriguez-Gomez and Talero Gutiérrez (2022) found significant heterogeneity among music programs, duration of the interventions and the methods that were studied in connection with the development of executive functions. According to this review, early music training can be associated with improved inhibitory control, particularly in preschool children, but the evidence for working memory and cognitive flexibility was inconsistent. This may be due to the fact that different music programs require different tools and skills; therefore they possibly could lead to different outcomes.

Because of this ambiguity, I chose to examine music education according to the Kodály concept which is a complex, student centred music program that is highly interactive and involves singing, instrument playing, movements, games, group, and individual activities, composition, and improvisation, moreover each musical element is grounded in sensorimotor activity and reinforced by a series of aural, visual and kinaesthetic stimuli (Kokas, 1972). It is also important that the aim of this concept is to make music education

accessible to everyone and teaches music in an intuitive and exploring way from the early ages.

2.3. The Kodály Concept

Zoltán Kodály was born in 1882 in Kecskemét, Hungary. He was a composer, ethnomusicologist, music educator and linguist. His internationally recognized music education concept is the core of public and professional music education in Hungary to this day.

For many people, the Kodály concept is usually associated with relative solmization, choral singing, folk songs and games, but this is only the surface of the method. His concept also contains philosophical and sociological ideas (Papp & Spiegel, 2019).

The term “Kodály method” spread after 1964, but perhaps, it is more appropriate to call it concept or philosophy (Papp & Spiegel, 2019) as Kodály himself never developed a teaching method. Kodály's ideas on music education were described in his speeches and interviews, and the Kodály method or concept is a practical translation of his educational philosophy (Kokas in Barkóczi & Pléh, 1977). It was developed over the decades by many of his colleagues and students (Szőnyi, 1973; Dobszay, 1991), who also studied music teaching approaches from all over the world and implemented the tools they found beneficial (Choksy, 1981). Although the developed method gives plenty of choice to teachers, the philosophy and principles behind it are the same.

The essence of the Kodály concept is that art, especially music education - following the examples of the ancient Greeks - should be at the centre of a child's education. Music education is always aimed at developing the whole person both intellectually and emotionally and has to start as early as possible.

Another essential part of Kodály's concept is that music must be accessible to all, not only to the privileged. The most accessible “instrument” is the voice; therefore singing should be in the centre of music education. Kodály was determined for music to be integrated into primary education, as only schools can bring music to masses, and school is where first musical experiences happen (Szőnyi, 1973; Dobszay, 1991). Therefore it is not enough to rethink the curriculum; instead, it is crucial to improve the training of music teachers.

Kodály did not primarily want to train musicians. He realised that Hungary, although it had educated a successful musical elite, had forgotten to educate its audience (Kodály in Eősze, 1970). Therefore his aim was to bring as many people closer to art music as possible. He was convinced that the key to reach this goal was active music-making through singing and mastering musical literacy, because that could lead to understanding and appreciating art music (Papp & Spiegel, 2019). Otherwise, music remains elusive and mysterious. (Kodály in Kocsár, 2002).

What we call a “method” is a carefully planned, logically structured guidance for musical skill and musical literacy development in which the children are given the tools and taught how to use them on their own (Kokas, 1972).

In this concept, every detail of musical literacy is gained from vivid experience. New musical elements are prepared and reinforced by a series of auditory, visual and kinaesthetic activities that are immediately integrated in many different ways into the children’s musical literacy practice (Kokas, 1972). The teaching sequence is based on the children's natural musical progression, starting from minor third through pentatonic scales, full scales and different modes (Choksy, 1999).

Kodály pointed out a number of tools to master musical literacy:

1. *Use of folk songs*

Kodály believed that only the best is good enough for children; therefore children should be taught with only the most valuable musical material (Szőnyi, 1973).

He emphasised the importance of folk songs especially at the early stages. Kodály was primarily captivated by the beauty of folk songs, not yet by their pedagogical potential. It was a lucky coincidence that the pentatonic scale, which is a very common feature of Hungarian folk songs, supports Kodály's suggestions of introducing half tones only after the intonation of the pentatonic scale is secure.

Kodály stressed that folk songs were important for students to learn their musical "mother tongue" and understand their cultural heritage. He believed that folk songs offer a direct pathway to other nations' folk music and to art music (Kodály in Kocsár, 2002); moreover folk songs are an excellent tool for starting musical skill development because of their simplicity and clear form (Dobszay, 1991).

2. *Singing games*

In kindergarten (age 3-6 in Hungary), the core of music training starts with songs linked to games. The singing games are the foundation of musical literacy; theory is extracted from the repertoire children have already mastered. Songs and movements are combined with games, which provides an opportunity for rhythmical development (Vajda, 1974). Moreover, the simplest two-three notes songs can already be translated into sol-fa syllables, and later these short melodic turns can be incorporated into larger units and notated on a staff.

The emotional and social benefits of the singing games are also important; these traditional children's games usually perpetuated village life; their relevance is still felt today, so it plays an important role in helping children to understand social relationships to enrich their imagination and to create an emotional connection with the repertoire. In these group

activities the children can also share their musical experiences and learn the individual's responsibility in the community (Dobszay, 1991).

2. Singing

Kodály stated that as many people as possible should be brought into direct contact with valuable music and be engaged in active musical life. The best way to accomplish this is singing and choral singing using this "free instrument" that is available to all (Kodály in Kocsár, 2002).

According to Kodály, singing leads most directly to experiencing and understanding music as it is extremely suitable for self-expression, communicating, and forming emotional relationships. Through choir singing, solidarity can be also taught (Kodály in Kocsár, 2002). Moreover, it also creates a pathway for the development of inner hearing which plays a crucial role in Kodály's music education concept.

3. Inner hearing

Inner hearing is an inner perception of the different relationships between sounds, pitches and time. (Kokas in Barkóczi & Pléh 1977). Kodály stated that a musician must hear what he sees and must see what he hears (Kodály in Eősze, 1970). He considered singing and relative solmisation to be the most suitable tool for the development of inner hearing and for the acquisition of musical literacy. "One should be able to transfer notation immediately into sound and vice-versa in the mind" (Szőnyi, 1973, p.16)

4. Relative solmisation

Kodály incorporated Curwens relative solmisation system quite late into his pedagogical ideas after he visited England (Choksy, 1999). Relative solmization has become

an effective tool for strengthening the sense of tonality, developing inner hearing and pure intonation in Hungary (Dobszay, 1991).

Relative sol-fa notes demonstrate the relationships between the notes and their role in the tonality rather than define the notes by their pitch height (frequency of vibration) as the absolute system does. Children learn these relationships in short melodic turns that are extracted from already known songs. Later, the same relations - as a part of a large unit - occur in constantly changing contexts (Kokas, 1972).

Kodály composed several booklets for practising sol-fa and preparing the students to solve various musical problems. The structure of these exercises can be compared to foreign language teaching; a motif or interval occurs in many different variations, in different places, rhythms, tempos, etc. The children therefore have many opportunities to practise, recognise, sing and re-use them in a variety of ways (Kokas in Barkóczi & Pléh 1977).

By pronouncing the sol-fa name of the notes, their role in the tonality is defined as well. With relative solmization, modulation can also be easily analysed - thus, a sense of harmony can be developed in unison singing as well (Dobszay 2009).

Later through relative solmization, the absolute system (ABC-names) is also introduced and used in the Kodály concept. Children learn to switch quickly between the relative and the absolute systems and to transpose the melody they learnt previously on sol-fa into different keys.

5. *Hand signs*

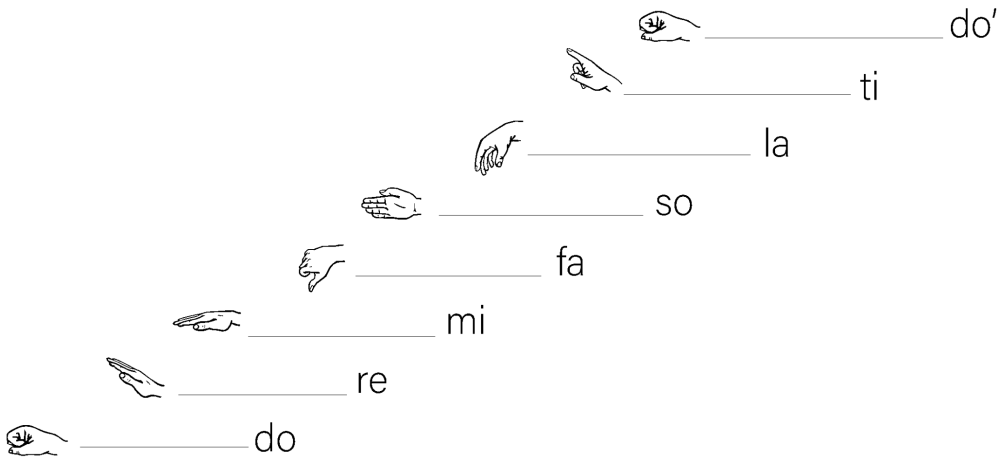
Sol-fa hand signs (see Figure 2) provide a visual and spatial representation of relative notes, recalling the name of the sol-fa syllables, thus helping to establish the relationship between the name and the sound (Papp & Spiegel, 2019). The hand signs are always

presented in relation to each other in space according to their pitch (Papp & Spiegel, 2019), so that children can see the contour of the melody.

Hand signs can be used for teaching new songs, as a cue for recalling songs learned previously, practising two part exercises (singing the first part, showing the other with hand signs) or showing modulation by transferring a note from one hand to the other. For instance in a dominant modulation one hand shows the hand sign of the “so” and the other shows the “do” at the same height. This way we can demonstrate that the pitch of the two notes is the same, but the tonality and therefore their function in the tonality has changed.

Figure 2

sol-fa hand signs



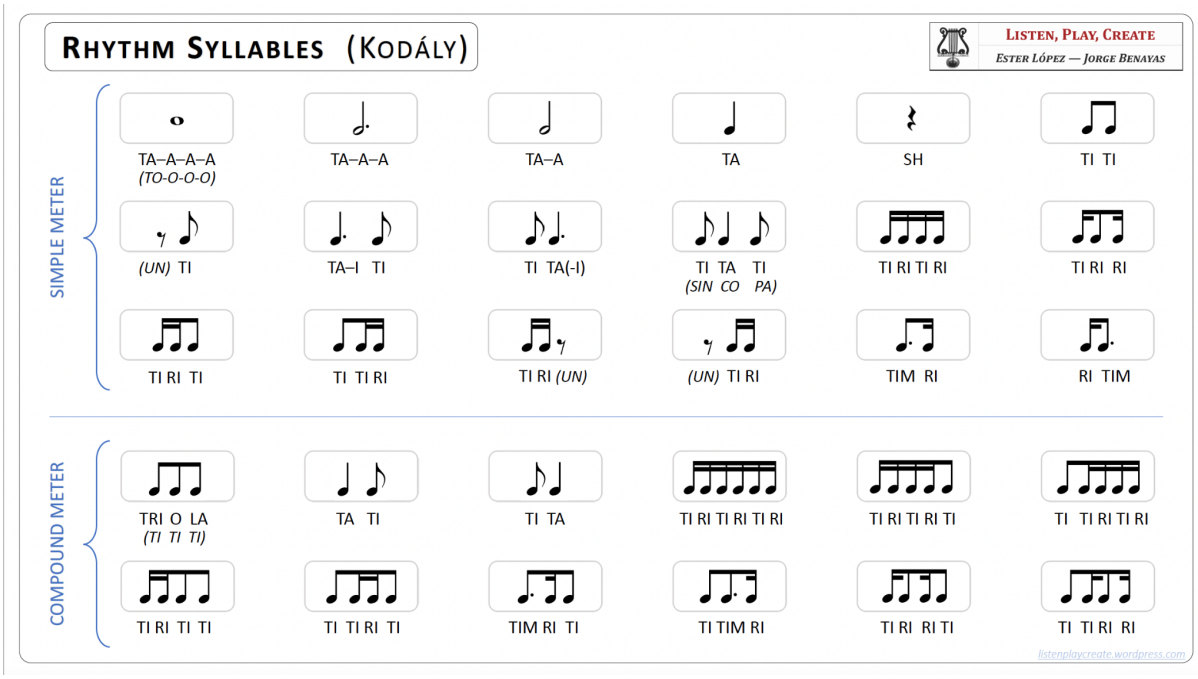
6. Rhythm language

The name of the rhythm units is adapted from Emile-Joseph Chêvé (Szőnyi, 1979). In this concept, the values of the sounds are represented with a specific syllable (see Figure 3)

regardless of their position in the metre. The acquisition of the rhythm is supported by movements adapted from Émile Jaques-Dalcroze's method (Szőnyi, 1979). It uses for instance walking related to quarter notes and running related to eighth notes (Choksy, 1999). These are the first rhythms children learn. Later, all the other rhythm elements are also prepared and practised by singing, clapping and moving. Only after that the students learn how to notate them.

Figure 3

Kodály rhythm names



Note. From "listenplaycreate.wordpress.com" by E. López and J. Benayas, 2022. (https://listenplaycreate.wordpress.com/2022/11/03/rhythm-syllables-systems-for-reading-rhythms-in-the-classroom/)

7. Developing polyphonic skills

According to Kodály, the ear can only fully embrace polyphonic music if people are able to sing one part without instrumental support, while listening to another part simultaneously (Kodály in Kocsár, 2002).

Polyphonic exercises are crucial in the Kodály concept and developing polyphonic skills already start from the very beginning of music education. The first step for developing polyphonic skills is walking a steady beat while singing a song. This is followed by singing a song while walking and clapping an ostinato. Here the attention is already divided into three parts. These exercises are then gradually extended to more complex ones in which the left hand taps differently from the right hand, later alternating the hands for a sign (Kokas in Barkóczi & Pléh, 1977).

8. Notation

The Kodály concept provides a specific way of notation, the "stick notation" or "staff notation" (see Figure 4). Stick notation does not indicate the absolute pitch; instead, it uses abbreviations of sol-fa syllables and a simplified notation of rhythm (indicated only by sticks). This way the characteristics of the rhythm, melody and form are demonstrated in a clear, simple way. Stick notation is used for preparing music notation on the stave, and later to make notation easier and faster in certain exercises.

Figure 4

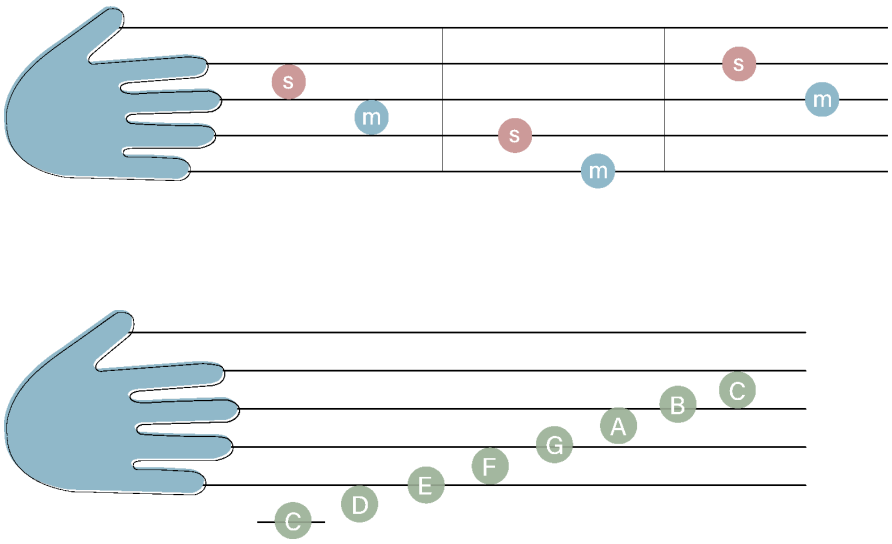
Stick notation

The so-called “hand stave” is also a frequently used tool for practising music notation in the relative and in the absolute system at the same time. The five fingers represent the lines of the music stave, while the spaces between the fingers represent the spaces between the lines (See figure 5). One hand demonstrates the stave, and with the other hand’s index finger the place of any note can be shown.

Alternating between different systems in notation is also likely to develop flexibility in children (Kokas in Barkóczi & Pléh, 1977).

Figure 5

“Hand stave”



Despite the highlight on the development of musical literacy, it should be emphasised that musical skill development is only a tool to reach the primary goal which is getting closer to art music, and through art music supporting the children’s emotional, intellectual and character development (Dobszay, 1991).

Kodály was convinced that “Music does not just teach music” and that active participation in music contributes to the development of the children's other faculties as well and influences their physical and intellectual abilities (Szőnyi, 1973).

A study by Klára Kokas (1972), Hungarian psychologist and music educator demonstrated that Kodály music education has a positive transfer effect on grammar, literacy, maths and gymnastics. These findings encouraged Ilona Barkóczi and Csaba Pléh to conduct a more complex and extensive longitudinal study (Barkóczi & Pléh, 1972). In this four-year research, they studied the impact of Kodály music education on intelligence and creativity. Their study found significant improvement in creativity (fluency, flexibility, and originality) among the children who had Kodály music education compared to the control group. Moreover, initial differences between the children who came from lower and higher socioeconomic backgrounds were significantly reduced.

Although these studies did not specifically study EFs, these findings inspired this research to study music education according to the Kodály concept in connection with EFs.

3. Research Method

In this research I study the tasks used for measuring EFs in comparison with the musicianship exercises of the Kodály concept and find analogies and connection points between them. The main focus of research will be a close examination of the tasks used for measuring the three components of EFs that are frequently highlighted by researchers, like working memory, inhibitory control, and cognitive flexibility.

Every component of EFs has tests for measuring its development. I will take frequently used tasks one by one and analyse them alongside the corresponding Kodály musicianship exercise.

Many musicianship exercises can be discovered that work in a similar way as EF tasks that assess inhibition (the ability to control automatic responses). In both exercises there is an interference between what the participant/students see and what they are required to perform and the goal is to ignore the dominant response.

There are also many musicianship exercises that correspond to tasks that measure cognitive flexibility (ability to change perspectives) in which the participants/students have to adapt quickly to changing rules. Working memory (keeping information in mind and manipulating it) could also be paired with exercises from the Kodály concept. Such analogous exercises will be ranged from simpler to more complex in each of the chosen components of EFs.

In order to achieve that goal, I will make use of the wide range of published literature from the last decades coming not only from Hungary, but also from international literature together with lesson observations at The Royal Conservatoire of the Hague and Junior Guildhall, London. The main research methods, therefore, are mapping comparable exercises including qualitative descriptions of the overlap and differences.

4. Functional Intersections

In this chapter I will introduce in depth the three core components of executive functions that are frequently highlighted by the researchers; inhibitory control, cognitive flexibility and working memory. My goal is to analyse the structure of the tasks that are used to measure the development of these three EF components in order to present functional intersections between these tasks and the musicianship exercises according to the Kodály concept.

In this chapter, the exercises are categorised according to the three EF components. However, it is important to point out that the Kodály exercises were not designed for

developing specific EF components, so completing an exercise often requires more than one EF component. For instance, some of the Kodály exercises that correspond with tasks used to measure inhibition require working memory when memorising and applying rules.

Additional exercises will also be presented that could not be paired with EF exercises, although they might challenge inhibition, cognitive flexibility or working memory.

4.1. Inhibitory Control

Without inhibitory control we would be exposed to environmental stimuli, impulses or old habits, but inhibitory control gives us the capability to focus, to be in charge of how we react, the power to change, to choose between patterns of behaviour, to think before we act, to resist temptations or stop unwanted thoughts and stimuli that are irrelevant for reaching our goals (Diamond, 2013).

Different aspects of inhibition can be distinguished. Inhibitory control of attention allows us to selectively focus our attention and concentrate on our goals ignoring distractions or irrelevant information (Diamond, 2013). Another aspect of interference control is cognitive inhibition that helps us to suppress dominant mental representations and prevent unwanted memories or thoughts from appearing in our minds (Anderson & Levy, 2009).

Self control and discipline are also part of inhibitory control. Self control enables us to resist temptations and not act impulsively. Discipline makes it possible to stay on task and helps us to give up an instant pleasure for something better later on (Mischel et al., 1989).

4.1.1. Psychological Tasks Used to Assess Inhibitory Control and Corresponding Kodály Exercises

In order to find functional intersections between inhibition tasks and Kodály musicianship exercises, I have considered studying the following commonly used EF measurements:

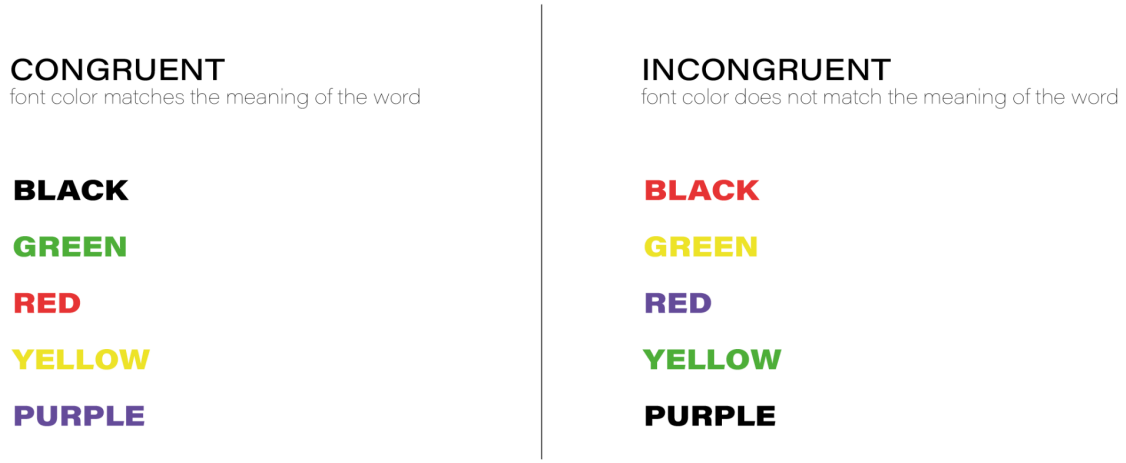
- Stroop tasks
- Flanker task
- Antisaccade test
- Go/no-go task
- Simon task
- Delay of gratification task

Stroop tasks (Stroop, 1935)

Stroop tasks are broadly used neuropsychological tests that measure focused and selective attention and the ability to inhibit irrelevant stimuli. In the widely known Stroop Color and Word Test (Stroop, 1935) the names of colours presented are written in different coloured ink (e.g. the word “blue” is written with yellow ink). As we are used to read the meaning of the words without considering the type of the font or the colour of the ink, when we are instructed to ignore the meaning of the word, but instead say the colour of the ink, our reaction time is slowed down because we have to first inhibit the dominant response (ignore the meaning) to be able to say the colour of the ink.

Figure 6

Stroop Color and Word task



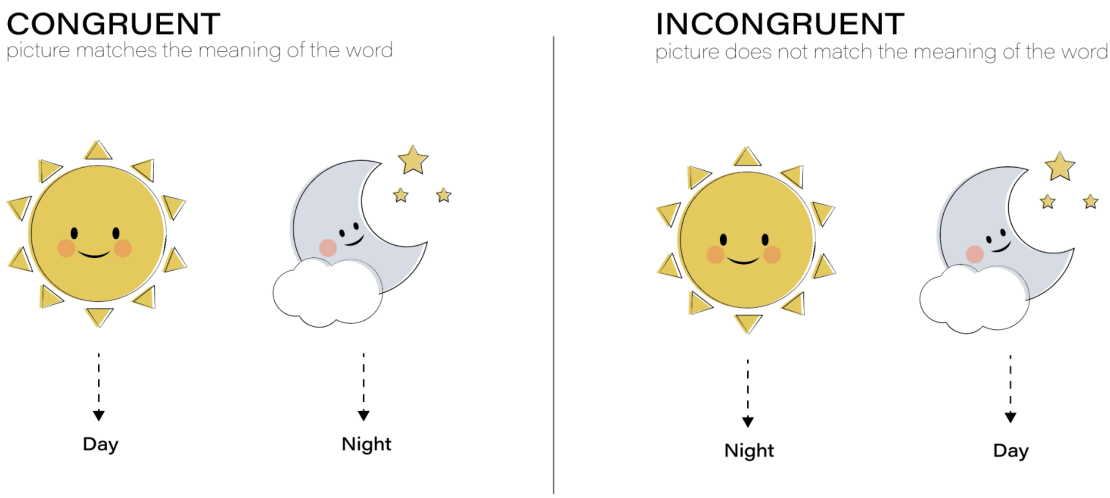
Another widely used version of Stroop task is e.g. Day-Night Stroop Task (Gerstadt et al., 1994) created for assessing children's inhibitory control between ages 3 and 7. (See Figure 7). In this task, children are presented two pictures with the sun on one and the moon on the other. Children are asked to say "day" when they see the picture of the sun, and "night" to the pictures of the moon.

In the second part of the task, they are instructed to do the contrary. When they see the sun, they are asked to say 'night' and when presented with a picture of the moon, they have to say 'day'. Inhibition appears in the second part of the task where the children inhibit the dominant response and ignore the association invoked by the images.

A similar concept is used in Grass-Snow task (Carlson & Moses, 2001). In the Grass-Snow task, the child is asked to point at a green card when he hears the word "snow" and a white card when he hears the word "grass".

Figure 7

Day-Night Stroop task



Corresponding Kodály exercises

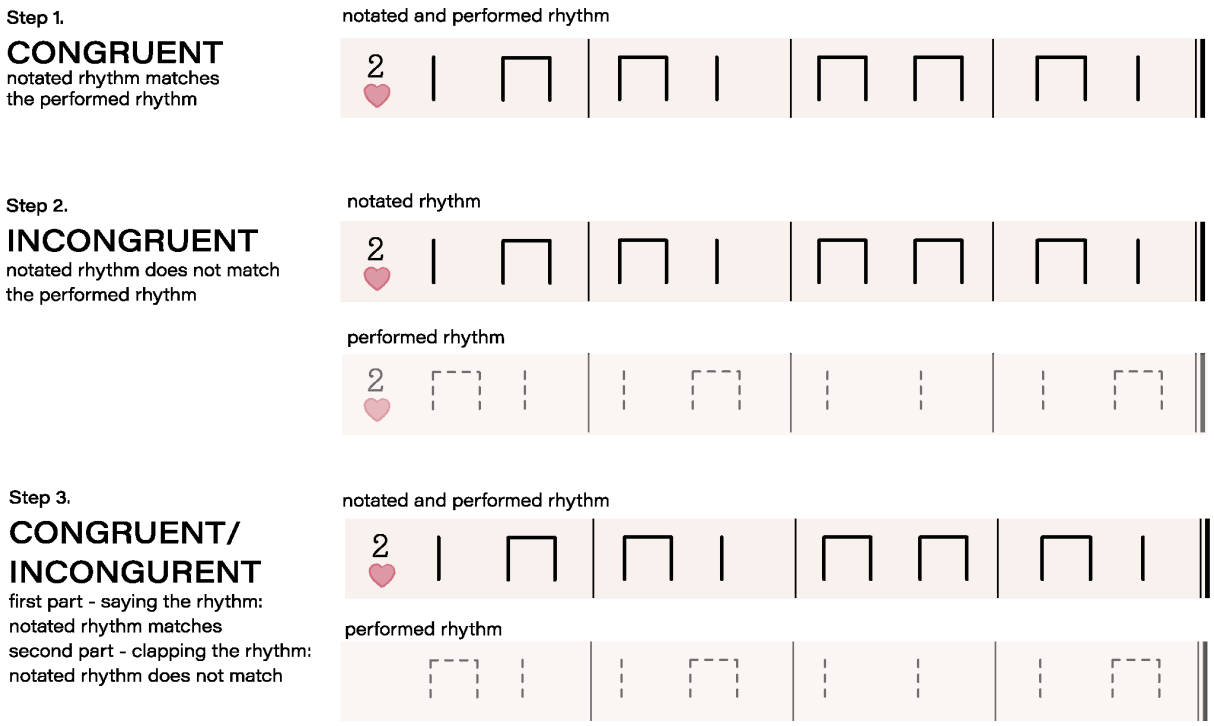
The following Kodály exercises utilise a very similar concept. Just like in Stroop tasks, students have to inhibit the dominant response and there is an interference between what they see and what they are required to perform.

Exercise 1:

Students are asked to clap a four-bar rhythm in 2/4 with “ta” and “ti-ti” and say the rhythm in rhythm language. In the next step, students are asked to read it again, but this time when they see “ta”, they clap “ti-ti”, where they see “ti-ti”, they clap “ta” (Papp & Spiegel, 2019). The third step can be to say the rhythm in rhythm language and clap its counterpart at the same time. Inhibition occurs when the students perform the counterpart of the written melody, because there is an interference between what they see and what they are asked to perform.

Figure 8

Exercise 1.



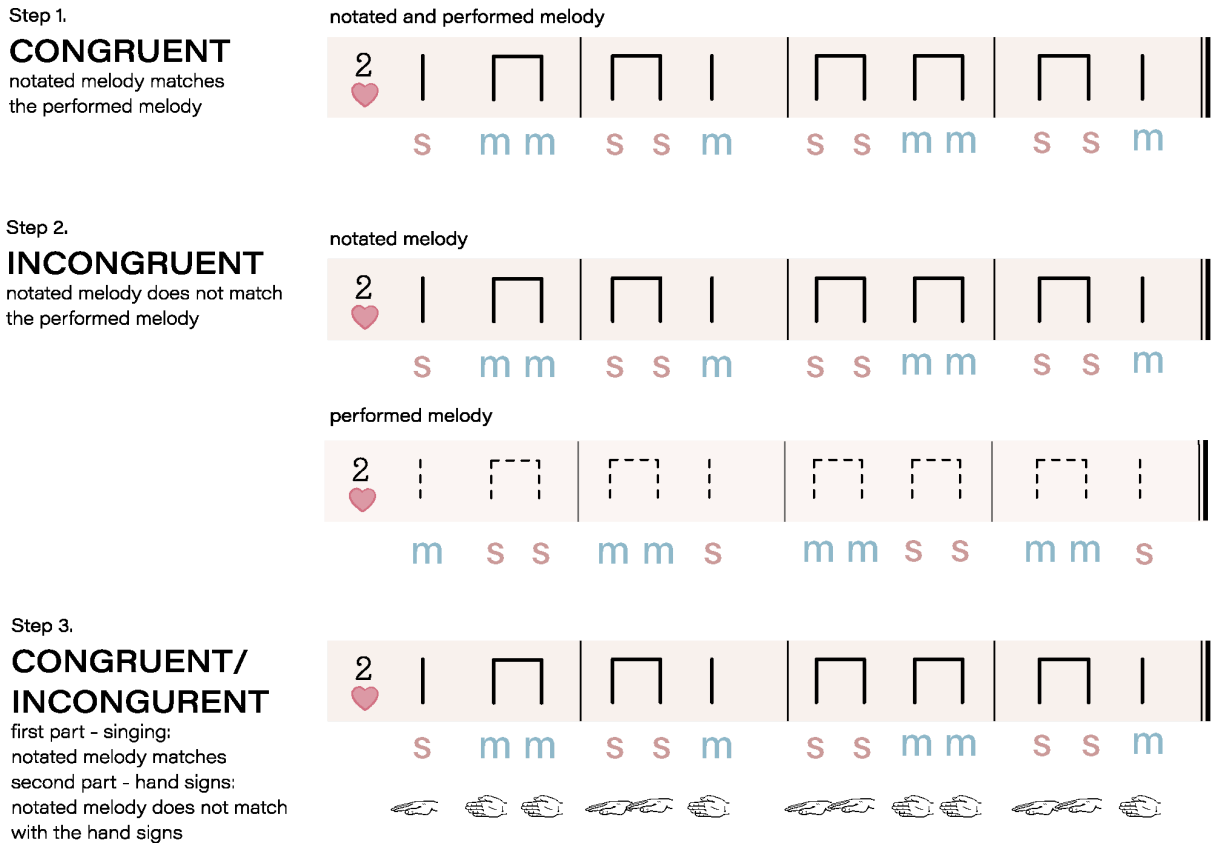
Exercise 2

Similar task with a “so-mi” melody: students sing the melody and are asked to turn it upside down and sing “mi” instead of “so” and sing “so” instead of “mi”.

As a third step, they sing the melody and show the hand sign of the counterpart simultaneously. Inhibition occurs in step 2 and step 3.

Figure 9

Exercise 2.



Exercise 3

"Hi Lo Chickalo" song and game - The children face each other in pairs. They hold their left hands back to back. Every time they sing 'hi', they clap each other's right hand high above their left hands. Every time 'lo' is sung, they slap each other's right hands low together below their left hands. The second step - where inhibition appears - is to sing and play the song "upside down" as shown below (Geoghegan, 2005).

Figure 10

"Hi Lo Chicalo"

Hi Lo Chicalo - Sing & Smile (Wednesday Week 1), Ages 5-8

Note. From "Hi Lo Chicalo - Sing & Smile (Wednesday Week 1), Ages 5-8" by NYCOS, 2020. (https://www.youtube.com/watch?v=LbCbvGNc5-A)

Exercise 4

Two children face each other. The pairs sing from each other's hand signs, while simultaneously showing each other a different pentatonic melody, so they have to pay attention to two things at once (Szabó, 2020).

Exercise 5

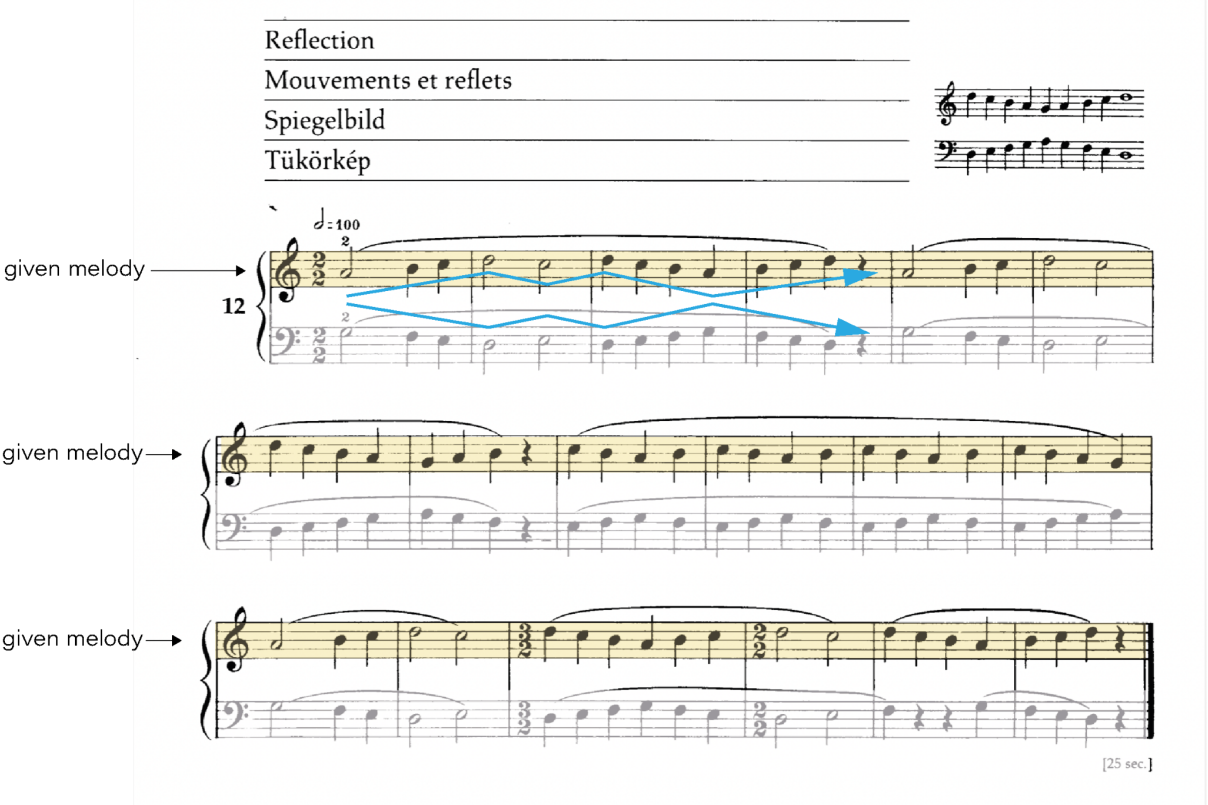
Pentachord mirroring and improvisation exercises based on Bartók: Mikrokozmos Vol.1, no.12 and no.14 (Szabó, 1978).

A) Mikrokosmos Vol 1, no.12 - in this piece, both hands start playing with the second finger on the piano. The two hands are mirroring each other, moving closer and further apart (see Figure 11) This mirroring gives the inspiration for the following singing exercises and this is

where inhibition appears. In the following exercise, only the upper voice is shown to the students.

Figure 11

Béla Bartók: Mikrokosmos Vol.1, no.12.



Note. Original sheet music from " Mikrokosmos" by Béla Bartók, published by Boosey & Hawkes, 1987.

First step: the students work in pairs, one pupil draws lines with his hand from an imaginary axis upwards. His/her partner projects this, moving simultaneously downwards from the horizontal axis. Inhibition occurs in the mirror movement.

Second step: the students sing the melody of the upper voice of Mikrokosmos 1, no.12. starting on the sol-fa note "la" and showing the melody contour with one hand. Then they

sing it again but this time they show the mirror movement (inhibition) as well with their other hands.

Third step: the students show the melody contour and its reflection with two hands, but this time they sing the melody's reflection a major second lower starting on "so". Only the melody of the upper part is shown to the students, they look at the music and read its reflection instead of the melody they see.

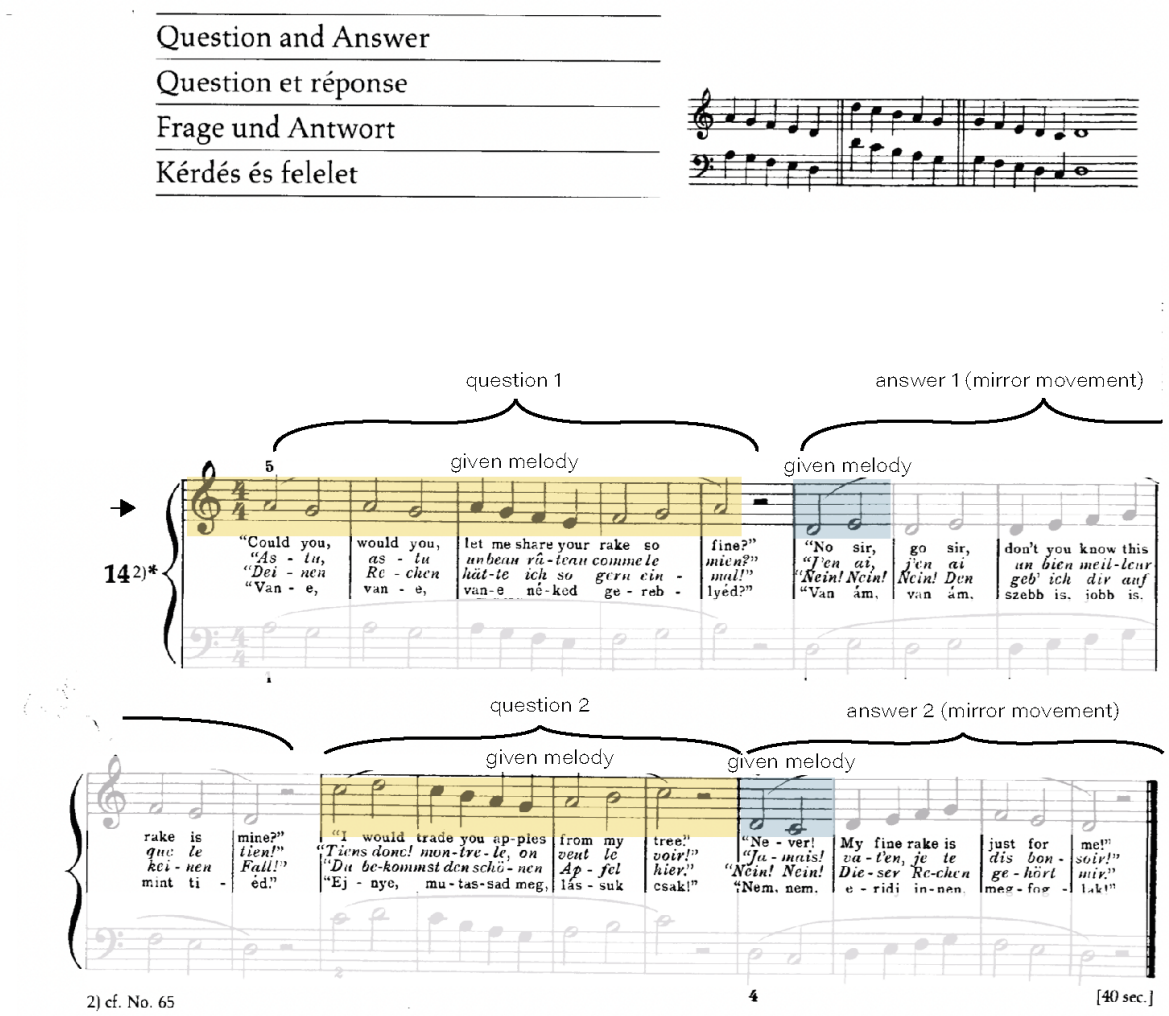
Fourth step: improvising a mirror image. The children work in pairs. One of them starts improvising slowly a pentachord melody starting on the solfa note "la" and follows the contour of the created melody with his arm. The other student sings the reflection of the improvised melody simultaneously a major second lower starting from "so" and shows its melody contour with his arm.

B) Mikrokosmos Vol.1, no.14: "question-answer" singing exercise. In this piece, the mirror movement occurs in the upper voice (See Figure 9). In this exercise only the musical question and the first note of the musical answer is shown to the children. They sing the "question" on sol-fa starting on "la" from the sheet and then they sing the musical "answer" by reading the same melody's reflection starting a fifth lower, on "re".

In both exercises inhibition (no.12 and no.14) occurs in the mirror movements, but working memory is also activated in these exercises.

Figure 12

Béla Bartók: Mikrokosmos Vol.1, no.14.



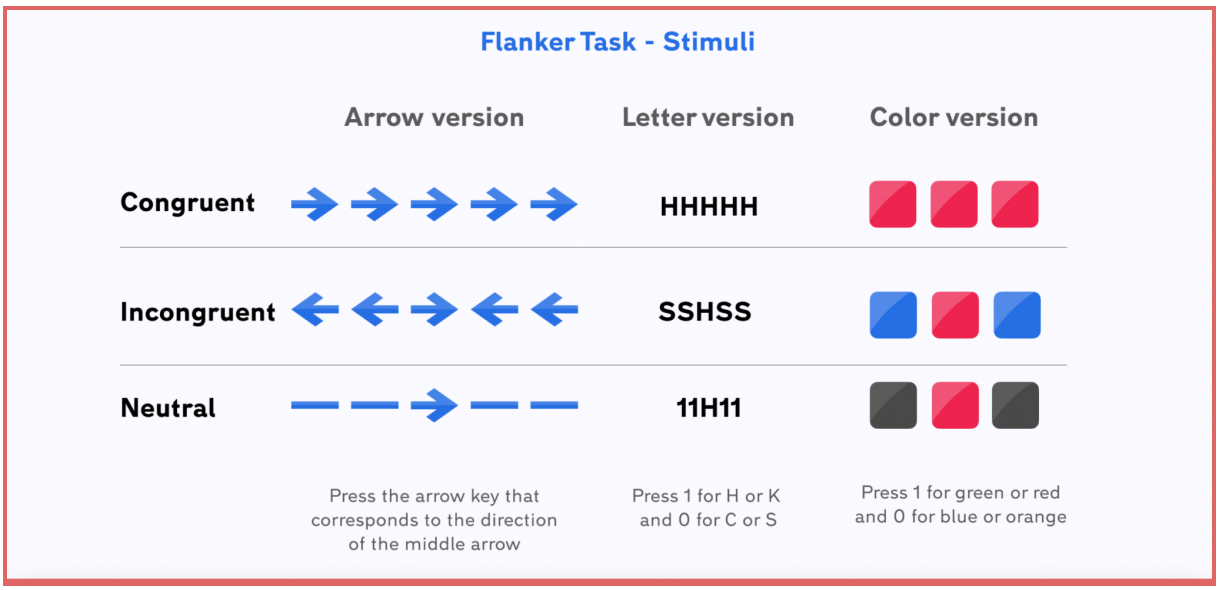
Note. Original sheet music from "Mikrokosmos" by Béla Bartók, published by Boosey & Hawkes, 1987.

Flanker task (Eriksen & Eriksen 1974)

The Flanker task (Eriksen & Eriksen, 1974) assesses spatial selective attention. In this task, the subject has to inhibit irrelevant stimuli to respond to a relevant target stimulus.

Figure 13

Flanker task

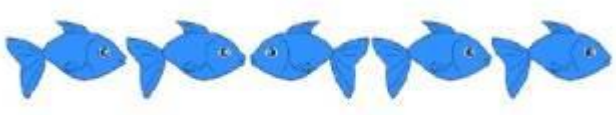


Note. Illustration of the various stimuli setups used in Flanker Task. From "testable.org", 2021. (https://www.testable.org/experiment-guides/executive-function/flanker-task)

Figure 14

Flanker task

Eriksen Flanker task for kids



Note. From "Eriksen Flanker task" for kids by Brain Health Lab, 2017. (https://www.youtube.com/watch?v=IXVmSqfSML4)

Corresponding Kodály exercises

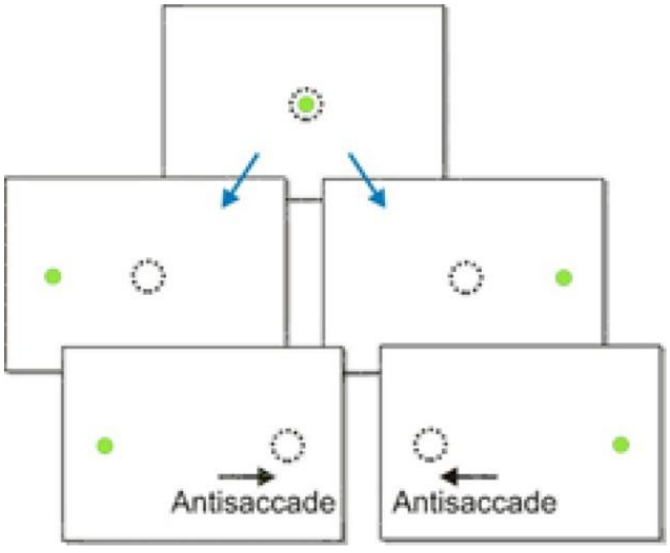
"Interval hunting": the teacher plays intervals and the children have to "hunt" for a given one, for instance a fifth. When they recognise it, they have to make a signal, by tapping on the table (Papp & Spiegel, 2019). In this exercise, just like in the Flanker task, the students have to inhibit the irrelevant information and only respond to the relevant stimulus.

Antisaccade test (Hallett, 1978)

Antisaccade test is a tool for investigating voluntary behaviour. In the test, the subject is required to suppress the reflexive eye movement and look in the direction opposite to the presented stimulus.

Figure 15

Antisaccade test



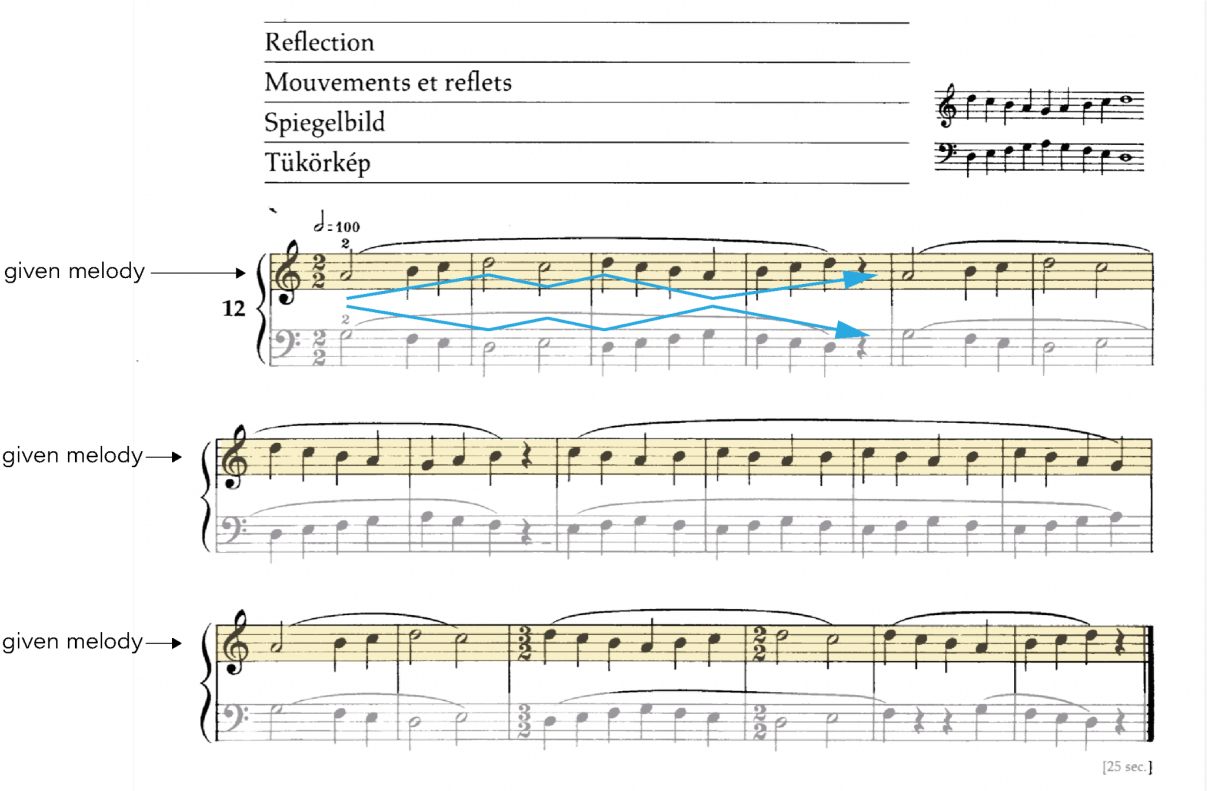
Note. From "LATER models of neural decision behaviour in choice tasks" by N. Imran, 2014, Frontiers in integrative neuroscience. 8. 67. (https://doi.org/10.3389/fnint.2014.00067)

Corresponding Kodály exercises

In connection with Stroop Tasks, exercises based on Bartók: Mikrokosmos Vol.1, no.12 were already mentioned, however those exercises also show similarities with Antisaccade task, when the students are asked to either show or sing the presented melody's reflection.

Figure 16

Béla Bartók: Mikrokosmos 1/no. 12.



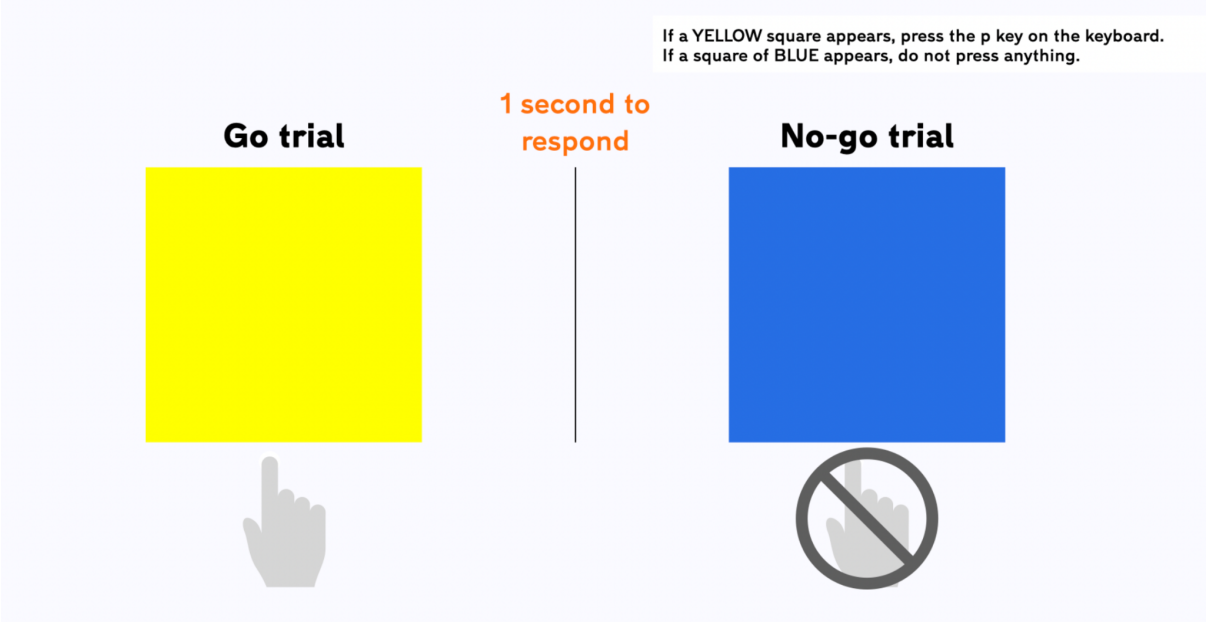
Note. Original sheet music from " Mikrokosmos" by Béla Bartók, published by Boosey & Hawkes, 1987.

Go/no-go tasks (Gordon & Caramazza, 1982)

In this simple interference control task, the subject is required to respond to a preset stimulus while ignoring the other stimulus.

Figure 17

Go/no-go task



Note. From "Go/No-go task" by testable.org, 2021 (https://www.testable.org/experiment-guides/executive-function/go-no-go-task)

Corresponding Kodály exercises

Exercise 1

The teacher sings a short song, and shows either the beat or the rhythm of the song with different movements (see figure 18). The children have to repeat the song and copy the

movements, but only if the teacher previously showed the beat. If the teacher showed the rhythm, they remain still.

Figure 18

Jolly Music in Action - Level 1 - Copy Cat

Note. “From Jolly Music in Action - Level 1 - Copy Cat” by jollylearning, 2013. (https://www.youtube.com/watch?v=Txu3RgAD9c4)

Exercise 2

The teacher has a wooden spoon; one side of it is green, and one side is red. The students start singing a song. When the teacher shows the red side of the wooden spoon, students have to stop singing loudly, they continue singing in their “thinking voice”, but when it turns green they continue singing again. The sign from the teacher is undetermined. Although when the students use their “thinking voice”, they are not singing the melody out loud, the music does not stop, they must follow the melody in their head in order to start singing again on time for the given sign (Papp & Spiegel, 2019). The amount and place of switching within the song depends on the teacher’s wish. The teacher can first give the signs in predictable places for instance after each line, but later he can use more challenging places

for swapping from “singing voice” to “thinking voice” and back. This exercise also works with rhythms, canons, and two-part melodies.

Inhibition occurs when the students have to stop singing and continue the melody/rhythm only on their “thinking voice”. Cognitive flexibility and working memory is also involved in this exercise. Cognitive flexibility is needed to switch between “singing voice” and “thinking voice”, working memory is needed to be able to follow the song in their head without singing it out loud.

4.1.2. Summary

Functional intersections were found in four of the EF tasks examined: Stroop task, Flanker task, Antisaccade task, and Go/No-go task.

The Kodály exercises that show similarities with EF tasks range from the earliest stage of music education to very complex tasks at advanced levels. For instance corresponding exercise with the Go/no-go task can be used as early as kindergarten, while the exercises based on Bartók: Mikrokosmos that match the Stroop and Antisaccade tasks are recommended for more advanced students.

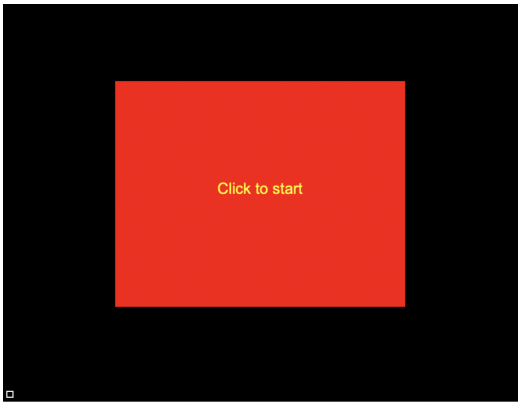
Although the main characteristic of the collected Kodály exercises shows similarities to the structure of the inhibition tasks, completing some of these exercises also involves working memory and cognitive flexibility.

Similarities were not found for the Simon Task (Simon and Rudell, 1967) and the Delay of Gratification task (Mischel, 1972). The Simon task is based on a concept similar to the one in the Stroop tasks, but in the Simon task, interference is generated by spatial features (see Figure 19). This could be the reason why I have been unable to find corresponding musical exercises.

Figure 19

Simon Task

PsyToolkit run experiment



Note. From psytoolkit.org (https://www.psytoolkit.org/experiment-library/experiment_simon.html)

In the course of the Delay of Gratification task, the child must choose between an immediate smaller reward and a larger reward in the future. One example of such a task is the Marshmallow test (see Figure 20), where one piece of marshmallow is placed in front of the children. If the children do not eat that piece of marshmallow by the time the experimenter returns, they will be rewarded with another marshmallow. For a greater reward, the child has to resist the temptation.

Figure 20

Delay of Gratification Task

The Marshmallow Test | Igniter Media | Church Video

Note. From "The Marshmallow Test" by Igniter Media, 2009. (https://www.youtube.com/watch?v=QX_oy9614HQ)

4.2. Cognitive Flexibility

Cognitive Flexibility is often associated with creativity: it enables us to adapt quickly and flexibly to changed circumstances, overcoming our old habits and choosing between tasks, responses, perspectives and strategies in order to achieve planned, goal-oriented behaviour (Cragg & Chevalier, 2012; Diamond, 2013).

Another aspect of cognitive flexibility is changing how we think or look at something, considering someone else's view of a situation, or solving a problem in more than one way (Zelazo et al., 2016).

4.2.1. Psychological Tasks Used to Assess Cognitive Flexibility and Corresponding Kodály Exercises

In order to find functional intersections between EF tasks and Kodály musicianship exercises, I have considered studying the following commonly used cognitive flexibility measurements:

- Verbal Fluency Task
- Letter Fluency Task
- Category Fluency Task
- Design Fluency Task
- Task-switching and set-shifting tasks e.g. Wisconsin Card Sorting Task

1. **Verbal/letter/category/design fluency tasks**

In this task, the subject is asked to generate as many words as possible within one minute in a given category (Category Fluency task) or start with a given sound (Letter Fluency task). Design fluency (Jones-Gotman & Milner, 1977) assesses the participant's ability to create visual patterns.

Corresponding Kodály exercises

Exercise 1

Based on the Categories Game, students are asked to collect as many musical terms, composers, instruments etc. starting with a given letter (Papp & Spiegel, 2019).

Exercise 2

For a given few-bars rhythm, the students are asked to compose as many melodies from a preset toneset for instance so, mi, do or pentatonic scale in a short time.

Exercise 3

Practising open and closed musical sentences. Students have to sing as many musical "answers" to the given musical "question" as possible; then the students are asked to notate the one they like the most (Szabó, 1988).

Exercise 4

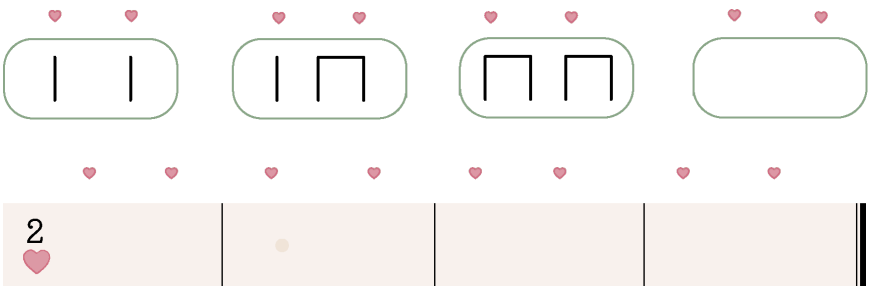
Practising ta and ti-ti: within two beats you can have these variations with ta and ti-ti (see Figure 21):

A) Which one is missing?

B) Create as many different four-bar variations with these elements as possible (Szabó, 1988).

Figure 21

Exercise 4.



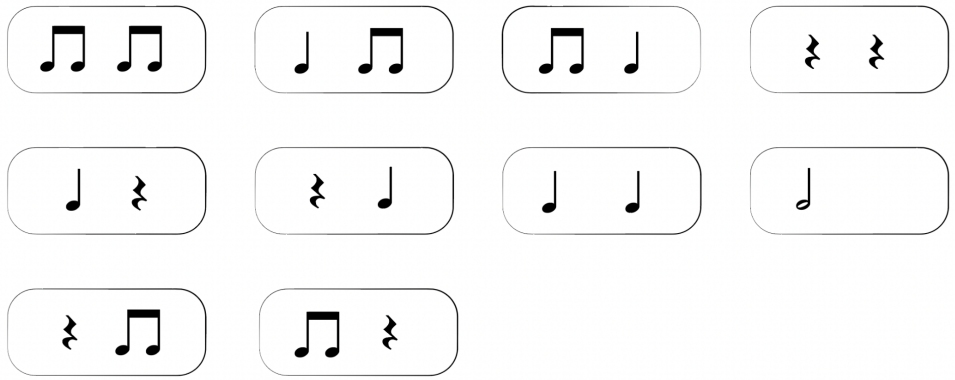
Note. Adapted from "Muzsikáló Munkafüzet" p. 26 by H. Szabó. Copyright 1988 by Helga Szabó.

Exercise 5

The students are asked to create as many different rhythms as possible by combining the bars written in the boxes below in several different ways (Szabó, 1988). See Figure 22.

Figure 22

Exercise 5.



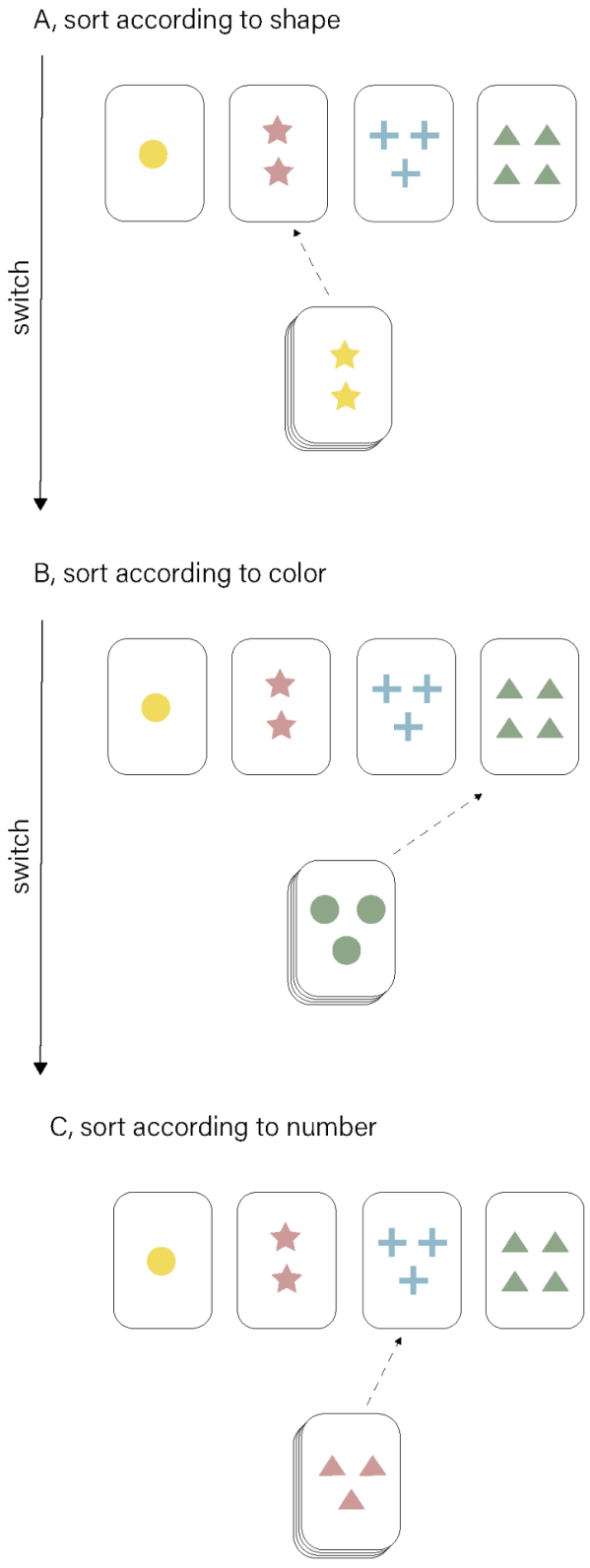
Note. Adapted from "Muzsikáló Munkafüzet" p. 26 by H. Szabó. Copyright 1988 by Helga Szabó.

2. Task-switching and set-shifting tasks

One of the most well known task-switching tests is the Wisconsin Card Sorting Test (Grant and Berg, 1948), which measures the ability to change strategy in response to external stimuli. 128 cards are sorted by colour, shape or number according to an unspecified rule. The rule changes after ten subsequent cards are sorted into the appropriate group.

Figure 23

Wisconsin Card Sorting Test



Dimensional Change Card Sort Task (Frye et al. 1995) works according to a similar concept (see Figure 24). In this task children are asked to sort the cards according to colour or shape.

Figure 24

Philip Zelazo - Dimensional Change Card Sort (DCCS) Task

Note. From “Philip Zelazo - Dimensional Change Card Sort (DCCS) Task” by iNajpod, 2012. (https://www.youtube.com/watch?v=Fv5DDyqGGAM)

Corresponding Kodály exercises

In the Kodály framework we can find many exercises where, just like in the above mentioned task switching exercises, students need to react quickly to the changing rules.

Relative solmisation itself requires the ability to adapt quickly to changing circumstances. For instance when the position of the “do” (tonic) changes within a piece. Because in the Kodály concept the relationships between the notes are emphasised, the accidentals are not always applied to only one note. The new accidental/accidentals can be the signal that determines the whole tonality of the upcoming section, to which the other notes must be adapted.

Exercise 1

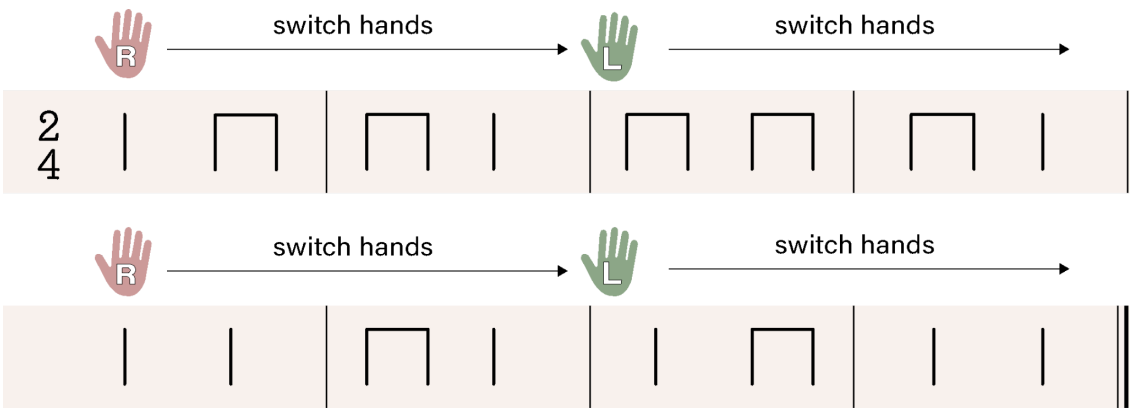
The teacher has a wooden spoon; one side of it is green, and one side is red. The students start singing a song. When the teacher shows the red side of the wooden spoon, students have to continue singing in their "thinking voice", but when it turns green they continue singing again. The amount and place of switching within the song depends on the teacher's wish (Papp & Spiegel, 2019). This exercise was also mentioned in connection with inhibition, but while inhibition occurs when the children stop singing and continue the melody in their head, cognitive flexibility appears when the students are swapping between "singing voice" and "thinking voice" for a given sign.

Exercise 2

"Ping-pong": preparation for two-part rhythm exercises. This exercise involves performing a rhythm with alternate hands (see Figure 25). The change of hands can take place after each bar, after each beat or after each written rhythm element (Papp & Spiegel, 2019).

Figure 25

Exercise 2: "Ping-pong"

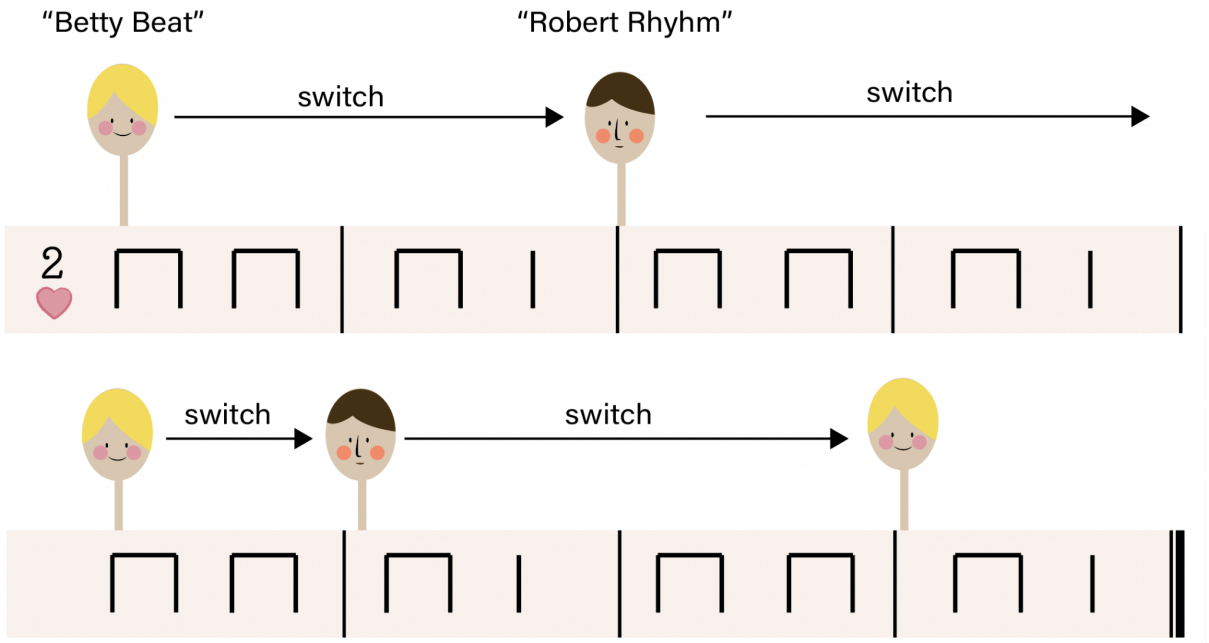


Exercise 3

"Betty Beat and Robert Rhythm": the teacher holds a wooden spoon. On one side of the spoon there is a drawing of "Betty Beat" which represents tapping the beat of a song. On the other side there is the face of "Robert Rhythm" who represents clapping the rhythm of the song (see Figure 26). The children start singing a song. If the teacher shows the face of "Betty Beat", the children must tap the beat, if the teacher turns the wooden spoon and shows "Robert Rhythm", they continue singing the song but they accompany themselves by clapping the rhythm. First the teacher can swap after longer periods and in more predictable places but later he can swap after shorter periods and in less predictable places (Hargittai, observation, 2018).

Figure 26

Exercise 3: "Betty Beat, Robert Rhythm"



Exercise 4

The students are presented with three images on the board (Figure 27). One represents singing the song's lyrics, one represents singing the same song in rhythm language, and the last one means singing the song in sol-fa.

The children start singing a song by heart (e.g. "Apple tree") on text (Figure 28). When the teacher points for instance at the image of sol-fa, the children continue singing the song in sol-fa. If the teacher points at the rhythm, the students are required to continue singing in rhythm language (see Figure 29). The teacher can swap between the images in different order and place. (Rowsell, observation, 2018). Working memory is also involved in this exercise.

Figure 27

Exercise 4: icons for "Apple Tree"

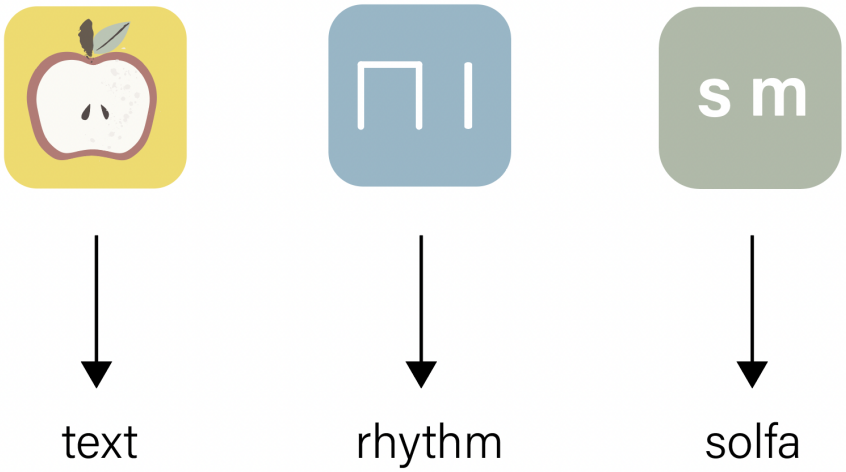
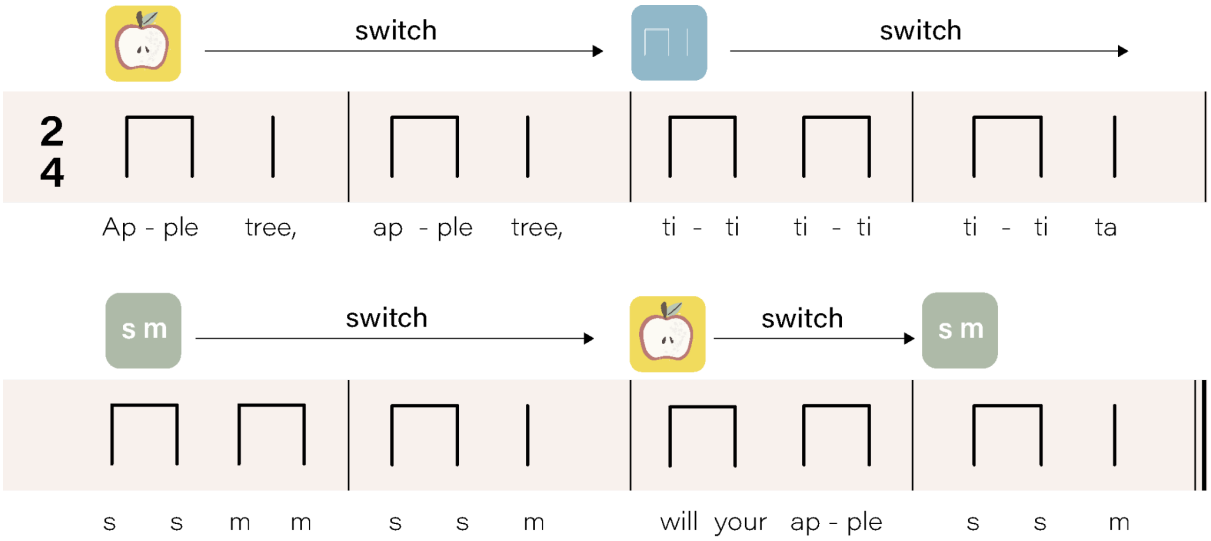


Figure 28

Exercise 4: "Apple Tree"



Exercise 5

The students are presented with a few-bars rhythm exercise. They are asked to perform the rhythm with one hand tapping the rhythm on the table and the other hand knocking the beat on the table. Immediately after performing the exercise they change hands. The hand that used to tap the rhythm is now tapping the beat and vice-versa. It is also possible to swap within the song for instance after each line. This exercise can be performed with two groups as a preparatory step.

Exercise 6

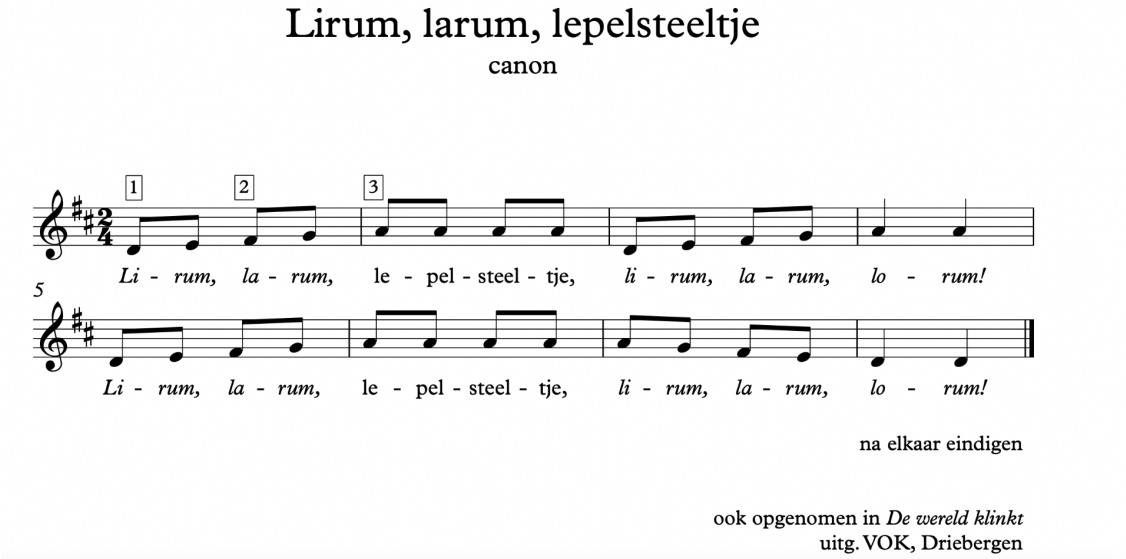
Practising a real sequence in sol-fa: students are asked to sing the following sequence: d m r = d m r = d m r = d m r = etc. Using relative sol-fa makes this exercise challenging, because it requires constant changing of "do" (Papp & Spiegel, 2019).

Exercise 7

Practising major and minor pentachords: the children sing a simple pentachord song for instance Lirum, larum, lepelsteeltje (see Figure 29) in sol-fa starting on “do”.

Figure 29

Exercise 8: Lirum, larum, lepelsteeltje



Note. From vrijeschoolliederen.nl (https://www.vrijeschoolliederen.nl/lied/lirum-larum-lepelsteeltje/)

A) As a preparation, students sing a major “do” pentachord scale in sol-fa and then a minor “la” pentachord scale starting from the same note. They start singing the song in sol-fa but on a sign from the teacher, they continue singing the song in minor, starting the sol-fa from ”la”. For another sign, they swap back to singing in major, starting from “do”. The place and the number of swaps depends on the teacher's wish.

B) A more challenging version of this exercise is when the teacher and the students sing in canon. The teacher starts humming the song and swaps between major and minor in certain places. The students follow the teacher in sol-fa after two beats. Two beats gives them enough time to determine the mode that the teacher sings. In this exercise students are required to listen to the teacher, decide in which mode the teacher sings and use the sol-fa notes accordingly while they are singing. This exercise also involves working memory (Hargittai, observation, 2018).

4.2.2. Summary

Functional intersections were found in both task-switching and fluency tasks. Just like in inhibition tasks, corresponding Kodály exercises were found at every level from kindergarten (task-switching exercise 1) to advanced level (task-switching exercise 7), and completing some of the exercises requires working memory and inhibition as well.

4.3. Working Memory

The Working Memory model was proposed by Baddeley and Hitch in 1974. It is a limited-capacity system that enables the storage and manipulation of information (Zelazo et al., 2016). Working memory is necessary for understanding written and spoken language, doing maths in our head, mentally reordering and updating items, translating instructions into plans, considering alternatives and finding connections between seemingly unrelated things (Diamond, 2013).

The model initially had three components: the central executive, the phonological loop, and the visuospatial sketchpad. They were later updated by Baddely to include the episodic buffer in 2000. The central executive is responsible for coordinating the subsystems,

maintaining attention, dividing attention between parallel tasks, and providing access between working memory and long-term memory. The phonological loop is responsible for storing "speech-like" information, while the visuospatial sketchpad is responsible for temporary storage and manipulation of visual information (Baddeley & Hitch, 1974). The episodic buffer connects information from the phonological loop and visuospatial sketch pad into a coherent whole. The episodic buffer also enables us to create representations that could guide our future actions (Baddeley & Wilson, 2002).

4.3.1. Psychological Tasks Used to Assess Working Memory and Corresponding Kodály Exercises

In order to find functional intersections between Working Memory tasks and Kodály musicianship exercises, I have considered studying the following commonly used working memory measurements:

- Cued recall test
- Nonword repetition task
- Corsi Block
- Self-ordered pointing task

1. **Cued recall tasks**

Cued recall is the retrieval of memory with the help of cues. In cued recall tasks participants are presented with a list of words to be remembered. The cues that help to recall words learnt previously could be the names of the categories in which the words were grouped, presentation of related words, incomplete pictures, letters within a word, etc.

Corresponding Kodály exercises

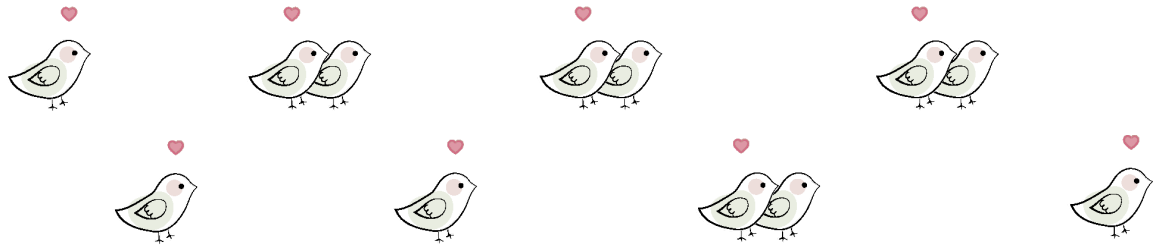
In the Kodály way of teaching, teachers often only give cues rather than instructing students to recall songs they learned in a previous lesson. Those cues could be visual clues e.g. images (see Figure 30) or sol-fa hand signs of the first few bars, or auditory cues e.g. teachers clap or hum the first few bars of the song.

Exercise 1

Which song is this?

Figure 30

Visual cue of the song "Koekoek, zeg mij toch"



The given cues in this exercise are:

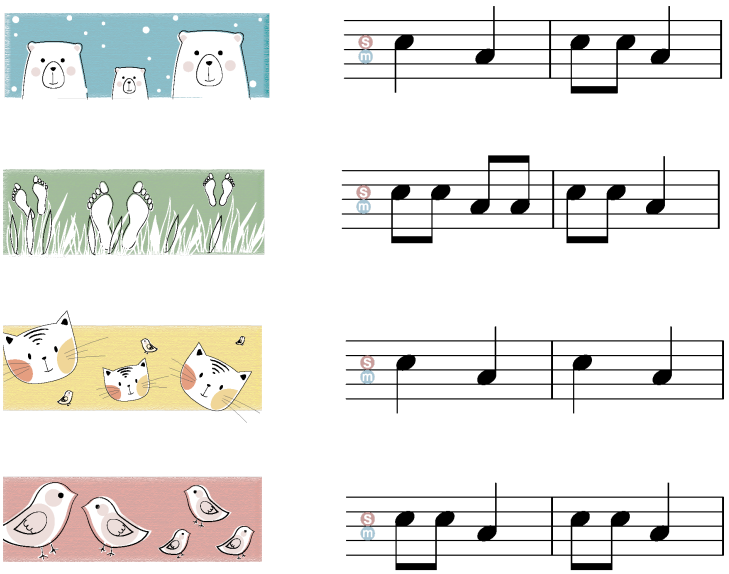
- the birds that represent the topic of the song (Koekoek, zeg mij toch)
- the spatial position of the birds that represents the melody line - minor thirds, "so" and "mi" on sol-fa
- the number of birds under one "heartbeat" represents the rhythm.

Exercise 2

Which image belongs to which melody (Szabó, 1988)? Students are asked to find the pairs, draw a line between them and sing the whole song (see Figure 31). In this exercise, the cue is the image which represents the story of the song.

Figure 31

Exercise 2



2. Nonword repetition test

The subject is required to repeat words with an increasing number of syllables, which are meaningless but have the same phonological structure as the participant's first language.

Corresponding Kodály exercises

Exercise 1

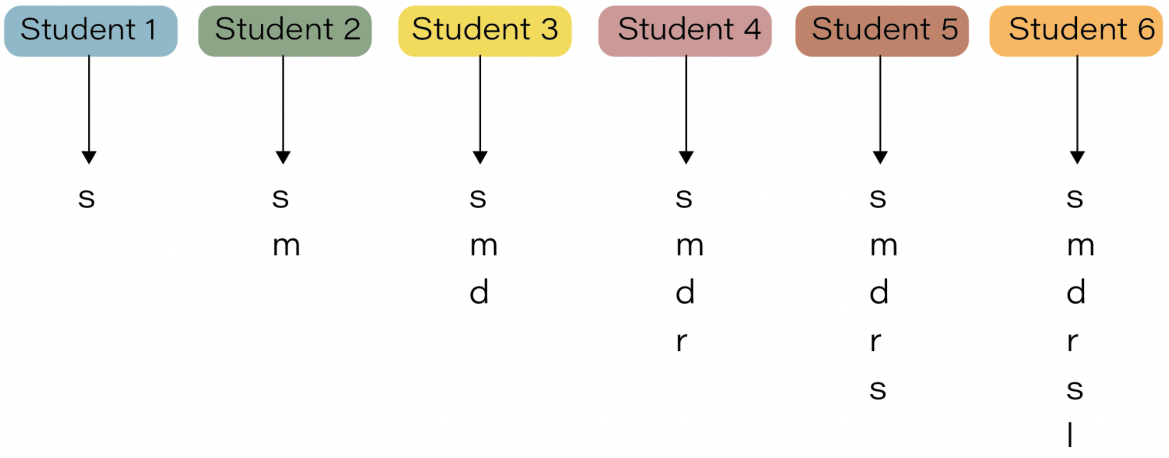
Rhythm snake: the first pupil claps a two-beat rhythm pattern. The second student repeats it and adds his own two-beat rhythm and so on. The group continues to build the rhythm snake up until they can no longer remember (Papp & Spiegel, 2019).

Exercise 2

Sol-fa snake: similar exercise but performed on sol-fa notes (see Figure 32). The group discusses how many notes can be used in the game e.g. do, mi and so or a do-pentachord. The first pupil sings one of the notes, the next repeats it and adds a new one, and so on (Papp & Spiegel, 2019).

Figure 32

"Sol-fa snake"



3. Corsi Block (Milner, 1971)

Nine cubes are presented on the screen and some of the cubes change colour for a short period of time. The task is to touch the cubes in the same order as they light up.

Figure 33

Corsi Block

Corsi Block

Note. From "Corsi Block" by SMARTfit, 2020. (https://www.youtube.com/watch?v=R7R54ziK-3M)

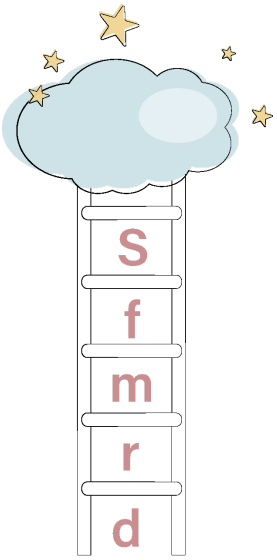
Corresponding Kodály exercises

Exercise 1

Dictation or learning new songs from "sol-fa-house" or "sol-fa-ladder": The teacher shows an unknown melody by tapping the corresponding sol-fa notes on the "sol-fa ladder" (see Figure 34). The students are not allowed to sing while the teacher is showing the melody; they first have to memorise it with their inner hearing. Then they can sing it out loud. (Rowsell, observation, 2018).

Figure 34

"Sol-fa ladder"



Exercise 2

Music dictation with hand signs: similar activity to the "sol-fa house", but this time the teacher teaches a new song with sol-fa hand signs. Inhibition also occurs in this and the previous exercise as the students are not allowed to sing the melody out loud while the teacher is showing the melody on the sol-fa ladder.

Exercise 3

The teacher sings a song or shows a musical excerpt or a piece of music. The children are presented with the sheet music but with the parts mixed up. They have to write it down in the correct order, but only after the teacher has finished the song/musical excerpt. This exercise uses auditory stimulus rather than visual like in the Corsi block task.

4.3.2. Summary

More than one functional intersection was found in cued recall task, Non-Word Repetition task and Corsi Block. As in inhibition and cognitive flexibility, the exercises cover all primary music education in all levels starting from kindergarten (cued recall exercises). Exercises corresponding with Nonword Repetition tasks require a more advanced level. As in the tasks of inhibition and cognitive flexibility, completing some of the corresponding exercises also involve more than one EFs component.

Similarities were not found in the self-ordered pointing task (Petrides & Milner, 1982) which assesses spatial working memory. In self-ordered pointing task, participants are presented with a booklet containing several sheets of paper. Each page contains the same items, for instance abstract drawings, but the position of the items varies randomly from page to page. Participants are asked to point to a different item on every page without pointing to an item they have touched before.

4.4 Additional exercises

The following Kodály exercises could not be paired with EF exercises, although they might challenge inhibition, cognitive flexibility or working memory.

1. **Working memory**

Exercise 1

Cat-Fish game: On the board there is a cat and a fish. The teacher sings two short melodies. One melody represents the cat, the other represents the fish. The teacher hums one of the two melodies and the children are asked to tell which one was sung; cat or fish? Then the teacher increases the patterns, first humming two phrases for the children to identify, then

four, for instance cat-fish, or cat-fish-fish-cat, or even longer. The exercise can work the other way around as well. The teacher presents a pattern e.g. cat-fish-fish-cat and the students have to sing the matching melody on sol-fa. Volunteers can also present their patterns instead of the teacher (Rowsell et al., 2019).

Exercise 2

A rhythm exercise is presented to the students. One student replaces one or two measures of rhythmic value from this exercise and claps it to the other students. The other students listen to where the change has occurred and indicate it by tapping on the table when they hear the change. After that, they name the new rhythm in rhythm language (Papp & Spiegel, 2019).

Exercise 3

Rhythm canon after listening: the teacher plays a rhythm on a percussion instrument. The students follow the teacher after one or two bars in canon by clapping or saying the rhythm in rhythm language (Papp & Spiegel, 2019).

Exercise 4

The teacher sings or only hums an unknown melody on sol-fa. The children follow the teacher in canon after a few beats on sol-fa. Another variation is that the teacher starts the canon only by showing the sol-fa hand signs and the children follow it in canon with singing.

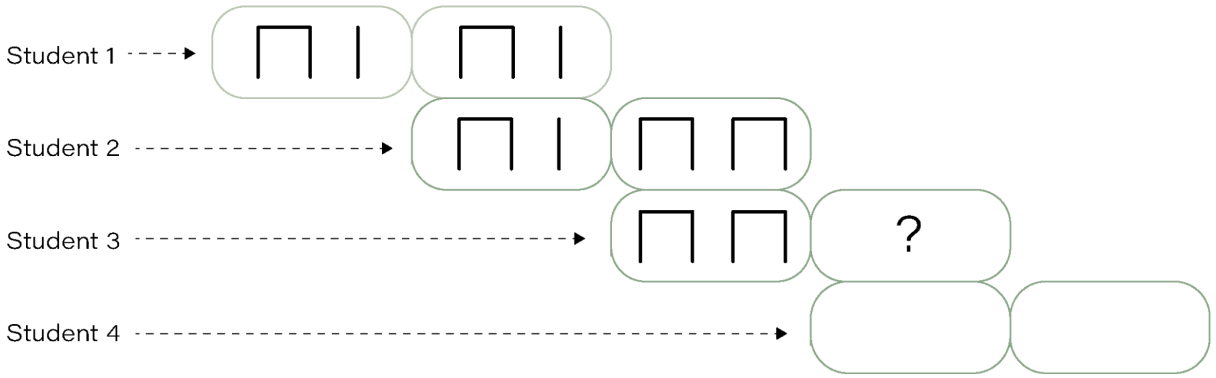
2. Working memory and cognitive flexibility

Exercise 1

Rhythm domino - the first pupil improvises a two-bar rhythm. The second pupil repeats the second bar and adds a new bar (Papp & Spiegel, 2019). While working memory is needed for keeping in mind the last bar of the partner's rhythm, cognitive flexibility is needed to switch between creating and repeating.

Figure 35

"Rhythm Domino"



Exercise 2

The students memorise a melody or a rhythm. They sing the melody on sol-fa or say the rhythm in rhythm language and perform a canon with themselves. If they are singing a melody, they show the second part with hand signs and then they perform it again the other way around, starting with the hand sign and following with singing. With rhythm, they say the rhythm in rhythm language and clap the second part in canon (or vice-versa) or perform the canon with two hands. Working memory is involved in the canon singing part, while cognitive flexibility (task switching) is involved when alternating between the order of the canon.

Exercise 3

In the Kodály way of music education it is a common practice to use hand stave for practising absolute note names. Students learn a melody and then they are asked to “put it on their hands” and sing the melody using note names. Usually they are required to transpose the melody to two or more keys after each other. For switching between the keys, cognitive flexibility is involved, for the transposition part of the exercise working memory is needed.

3. Working memory, Inhibition

Exercise 1

The students are asked to sing a given song in their heads. Without singing it out loud (inhibition is needed), they need to answer questions about the song (Dobszay, 1967). This is the part where working memory is activated.

- How many bars are in the song?
- In which bar do you sing a certain word?
- What would you call the highest note on sol-fa?
- On which note do you finish the first part of the song if we start it on B?
- What is then the last note of the song?
- What is the rhythm of the very last bar?

Exercise 2

Two-part music dictation tasks - according to Kodály, the ear can only fully absorb polyphonic music if we learn to sing one part in unison, without instrumental support, while listening to another (Kodály in Kocsár, 2002)

A) First the teacher dictates the first voice of the melody/rhythm. When the students are ready, they sing the dictated melody while the teacher sings the second part. The students are not allowed to write the second part down, they have to memorise it while singing the first part.

B) Two groups are sitting back to back each other in two lines, so they can not see each other. Both groups perform a different given rhythm simultaneously using two different sounds (the groups do not know each other's rhythm). They perform the rhythm a couple of times while they have to memorise each other's rhythm (Salbert, lesson observation, 2022).

C) The students sing their own part, but at the same time they are required to listen to the other part and hand sign it while singing their own part.

In these exercises working memory is involved in the memorisation part of the exercises, inhibition occurs when the students ignore their own part in order to be able to listen to and memorise the other part.

4.4.1. Summary

Many exercises were found that could not be paired with EF exercises, but might challenge the three core components of EFs. The exercises presented mostly require working memory, but they challenge cognitive flexibility and inhibition as well - therefore with these exercises diverse EF skills could be practised. These exercises require a more advanced level than the exercises that could be more directly paired with EF tasks.

5. Discussion

This study has found functional intersections between the tasks that assess the development of all the three core components of EFs - inhibition, cognitive flexibility and working memory - and Kodály musicianship exercises in every level from kindergarten throughout the school years. Additional exercises were also found that could not be paired with specific EF tasks, but might challenge all the three components of EFs. As creating musicianship exercises according to the Kodály concept did not aim to train specific EFs components but to provide a deeper understanding of music, although the corresponding Kodály exercises presented in this research could be directly paired with each EFs components, completing many of these exercises require other EF components as well. Therefore, diverse skills can be practised with each exercise.

These findings could indicate that with Kodály music education approach we are not only practising musicianship exercises but we might also challenge our EF skills throughout the school years. This is especially important as preschool years and the transition to adolescence seem to be a promising time for interventions (Zelazo et al., 2016).

Although this research does not confirm the Kodály concept's positive impact on EFs development, it can be a first step that leads to a more complex investigation and can suggest future directions for studying music education according to the Kodály concept in connection with the development of EFs.

This study shows that although corresponding Kodály musicianship exercises were found at every level, already from kindergarten, the majority of these exercises require a strong foundation of Kodály music education where the children establish the basis of rhythm and sol-fa. Therefore these findings could suggest that longitudinal research is needed to explore the Kodály concept's possible benefits on EFs especially on working memory where the majority of the presented exercises require a more advanced level.

It also needs to be mentioned that Kodály's educational philosophy is much more than only the musicianship exercises. It would be interesting to explore the long-term impact of music education according to the Kodály concept on the development of EFs by studying children who receive Kodály music lessons according to Kodály's original recommendations; starting music education as early as possible multiple times a week, including choir singing and considering the children's emotional, social, character and intellectual development as equally important.

Limitations

This research could indicate that music education according to the Kodály concept might have some impact on the development of EFs, but further and more complex research is needed to determine the exact extent and nature of this impact.

Although a wide range of EF tasks and Kodály methodology books were studied, not all the available musicianship exercises and EF tasks were collected. The studied methodology books mostly concentrate on primary music education; singing games which give the core of music lessons in kindergarten and exercises in higher education have not been studied. Moreover, as Kodály never developed a systematic curriculum himself and only shared his thoughts on music education instead, many exercises are common practice among Hungarian music teachers without any written source, which makes it challenging to decide when to really talk about Kodály exercises.

Conclusion

The present study found functional intersections between Kodály musicianship exercises and tasks that are used to measure the development of the three core components of EFs; inhibition, cognitive flexibility and working memory. These findings therefore could be

a first step that leads to a more complex investigation into the positive impact of the Kodály Concept on EFs.

If such positive impact is confirmed, an immediately accessible, enjoyable method could become available and easily incorporated into the school curriculum. Since this method does not require purchasing any instruments or making other investments and can be readily implemented by teachers willing to learn and adapt this concept to the needs of their students, the potential outreach would be large-scale and include the most vulnerable pupils who can take the most advantage from the lifelong benefits of EFs such as school achievement, positive behaviour, good health, relationships, and work success together with the joy of music.

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