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THE BLUE STRAWBERRY AND A GIANT MOUSE? STROOP EFFECT IN ASSESSMENT OF INTERFERENCE CONTROL IN PREREADING CHILDREN

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ГОЛУБА ПОЛУНИЦЯ АБО ГІГАНТСЬКА МИША? ЗНАЧЕННЯ ЕФЕКТУ СТРУПА ДЛЯ ОЦІНКИ ІНТЕРФЕРЕНТНОГО КОНТРОЛЮ У ПРОЦЕСІ НАВЧАННЯ ЧИТАННЯ ДІТЕЙ

У статті проведено теоретичний аналіз дослідження, метою якого є підготовка комплексу вправ на основі ефекту Струпа, який пояснює інтерферентний контроль у дітей, що навчаються читати. Інтерферентний контроль полягає у здатності швидко адаптуватися за умови перцептивного конфлікту. Інтерферентний контроль передбачає також вміння пригнічувати спонтанну/домінантну реакцію на стимули, а натомість застосовувати неконгруентну, неавтоматизовану реакцію. Перцептивний конфлікт вказує на прихований характер реакції у більшості осіб, що брали участь у дослідженні. Окреслено поняття інтерферентного контролю та методи діагностики інтерферентного контролю у дітей, що навчаються читати. Результат проекту може привести до теоретичного обґрунтування методичної спрямованості на підготовку гальмівних процесів у дошкільних закладах з адекватними методами і дидактичними засобами, а також уможливить надання коротких інструкцій для батьків.

***Ключові слова**: контроль перешкод, ігнорування контролю, ефект Струпа, когнітивний розвиток, дошкільний вік.*

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ГОЛУБЯ КЛУБНИКА ИЛИ ГИГАНТСКАЯ МЫШЬ? ЗНАЧЕНИЕ ЭФФЕКТА СТРУПА ДЛЯ ОЦЕНКИ ИНТЕРФЕРЕНТНОГО КОНТРОЛЯ В ПРОЦЕССЕ ОБУЧЕНИЯ ЧТЕНИЮ ДЕТЕЙ

В статье раскрыты теоретические основы проекта, направленного на подготовку набора задач, основанных на эффекте Струпа. Кон-

троль препятствий показывает способность реагировать адаптивно в то время, когда происходит конфликт. Контроль препятствий включает в себя способность подавлять спонтанную/доминирующую реакцию на раздражители и активировать ответ. Результат проекта может привести к теоретичному обоснованию методической направленности на подготовку тормозных процессов в дошкольных учреждениях с адекватными методами и дидактичными средствами, а также позволит предоставить краткие инструкции для родителей.

Ключевые слова: *контроль препятствий, игнорирование контроля, эффект Струпа, когнитивное развитие, дошкольный возраст.*

Introduction

In 1886 James McKeen Cattell reported the phenomenon which concerned the influence of the type of a stimulus on the speed of verbal fluency [3]. Cattell noticed that reading the word is more prepotent and spontaneous reaction than naming aloud the color of a print of a word. In the thirties of XX century John Ridley Stroop devised a test which consisted of series of words naming different colors [19]. In this test, individuals are presented with incongruent color word stimuli, for instance the word «blue» printed in red ink. They are then asked to name the color of the word (the ink color). Stroop observed that responding «red» to the word «blue» displayed in red letters is slower than responding «red» to a red patch of color. This phenomenon is known as Stroop effect or interference effect. As Bower writes [3, 312], people during performance experience *«mental sensation comparable to running in the swimming pool – you just can't do it quickly»*. Further investigations documented latencies of response execution both in children and adults, with typical and atypical development [16, 14, 6, 21, 2]. Contemporary research documents explicitly that naming the colors is less automatic reaction than reading words of colors printed in black. To better understand what interference control is and how it develops, it is necessary to consider interference control in a wider context as one of two components of inhibitory control [15].

As *figure 1* demonstrates, inhibitory control consists of two sub-processes which are interconnected as they rely on the same mechanism of inhibition but differ from each other [9]. Inhibitory control involves: the ability to stop automatic but incorrect response (response inhibition) or to resist interference from distracting stimuli (interference control). In other words, a person may be asked to inhibit a reaction (not eating a candy when is asked for it) or to inhibit attention resources when has to read the names of colors instead of reading words (which is more prepotent). Interference control is crucial during initial perceptual stage of processing (while two conflicting stimuli appear at the same time) and response inhibition seem to function during further stages of information processing (when initiated reaction is no longer adequate and has

to be suppressed because of new requirements). This distinction between two sub-processes underlie the concept of non-unitary nature of inhibitory control.

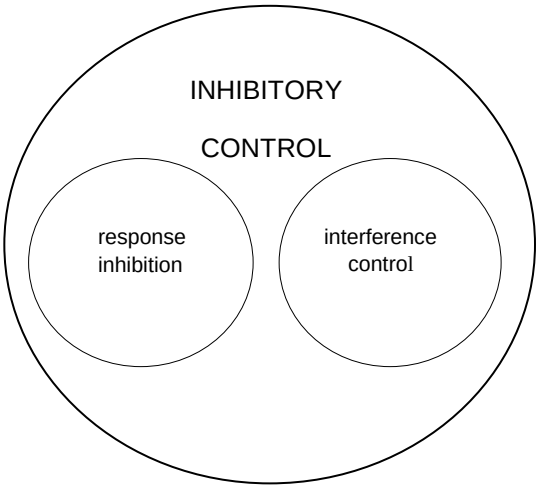

Figure 1. Non-unitary character of inhibitory control

Review of so-far research

Response inhibition

This component of inhibitory control involves the ability to stop a prepotent, automatic action (for example crying when upset, eating a treat or unpacking the gift while asked to stop this action). At the end of the first year of life we can observe children who stop themselves from doing something attractive when parent or a caregiver ask them to do so. Research [12, 5] indicate developmental changes in response inhibition between 8 months and 4 years as children are taught to delay their gratifications in time and to stop their impulsive behaviors.

Interference control

Interference control is regarded as the most cognitive and advanced form of inhibitory control. Scientific research which document the trajectory of its typical development are scarce and not well systematically documented. Interference control involves the ability to suppress distracting stimuli (internal or external) from interfering with 1) current cognitive operations in working memory and/or 2) carrying out a motor response. Both cognitive and motor processes are entailed in this activity [11] but little is known how these two processes develop in childhood. For example, child may be requested to show different parts of his body when asked by a doll while ignoring the same requests of a bear. This simple play is based on interference control as a child has to activate or suppress current cognitive operation (listening to oral instruction from a doll or a bear) from interfering with motor response (e.g. showing a nose). Children < 3 years have difficulties in suppressing the dominant ten-

dency to show parts of their bodies because cognitive control is not yet developed. Interference control plays a crucial role for early cognitive development [15, 13]. The classroom environment is full of distracting stimuli. Efficient interference control processes enable picking up relevant information in a complex mathematical task or organizing a written response. In everyday life interference control is responsible for adaptive and flexible behaviors in changeable circumstances (e.g. during play, when the rules change). Disorders which are marked by problems with poor interference control (e.g. ADHD) could be better explained by understanding of the development of interference control.

Current point and further propositions of research

Since Stroop Effect and interference control gained popularity in psychological research in a wide range of population, the special attention has been focused on prereading children. Attempts have been undertaken to develop measures based on Stroop interference effect, but with no reading skills required. Some of such methods are the fruit Stroop task [1], the color-object Stroop task [17] and the Real Animal Size Test [4]. The review of present studies indicates there is a developmental progress in these tasks between 5 and 8 − 9 year of life.

Since color naming is usually acquired before reading, Santostefano [18] was first who documented a relatively strong interference effect among kindergarten children presented with a non-verbal version of Stroop test (named Fruit Distraction Test). Since then, many versions of this task appeared. Generally a task requires children to name the color of drawings representing correctly and anomalously colored fruits or vegetables. For example, at the first session, a child is presented with the drawings of fruits and vegetables printed in congruent colors (e.g. a yellow banana or a red strawberry). A child is required to say the color of a fruit. In the incongruent session (experimental trial), fruits are printed in incongruent colors (e.g. a black banana or a blue strawberry) and a child is required to say the real color of a fruit as quickly as possible. In the Real Animal Size Test, participants are presented with pictures of animals on the computer screen (large animals such as an elephant vs. small animals such as a mouse) displayed as either big or small. Each time they have to decide the real size of an animal by pressing a response key. The results suggest that Real Animal Test is a good measure of inhibitory control in 5 − 9 year old children [4].

First and second row present animals in congruent size. A child has to say the real size of an animal (small or large). Third and fourth row present the same animals in anomalous size and a child has to name the real size of an animal (and inhibit focusing attention on the superficial size of an animal).

Other proposition of Stroop interference assessment in children is color-object task [17]. In this research 3½ – 6½ years old children were presented with line drawings of familiar objects drawn in color that was congruent (e.g.

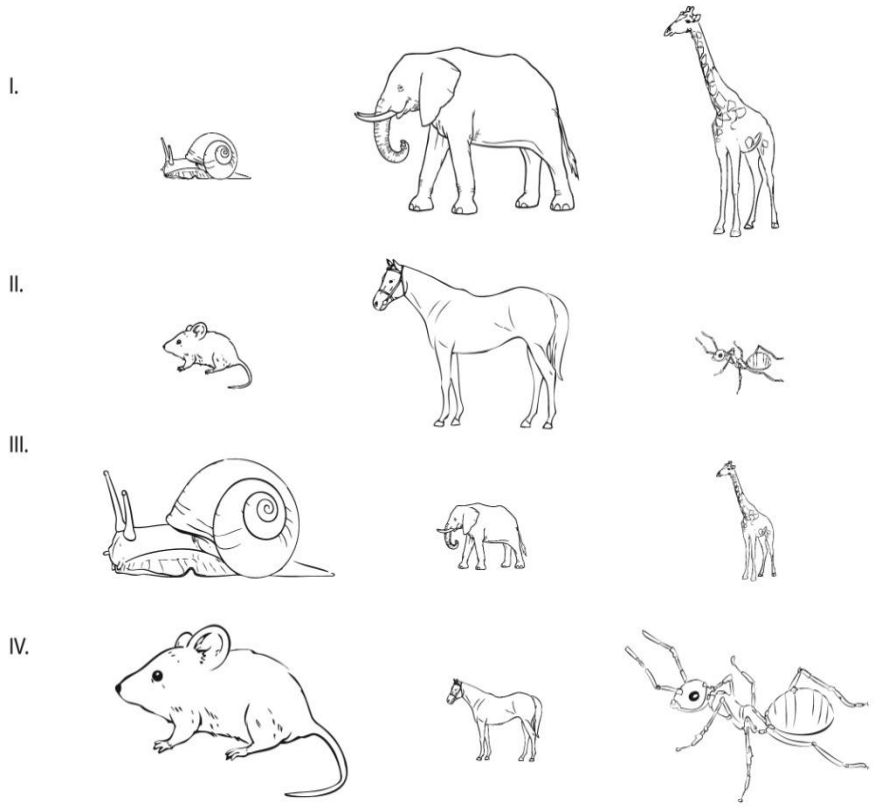

Figure 2. The Real Animal Size Test (example)

a red heart, orange carrot), incongruent (e.g. a green heart or carrot) or neutral (for objects which have no specific color, e.g. a red book), and abstract shapes painted in one of six colors. The results showed that children's dominant reaction was to say what the object was and were slower and less accurate when had to say their colors. However, they were more accurate during naming color of abstract forms compared to real objects (interference was less strong then). Authors explain why object naming objects is prepotent over color naming: children and adults have a similar tendency to focus on what an object is rather than to its color (which is only one of its surface facets). It was reported in previous research [10, 20] that children and adults are inclined to classify by shape (object kind) rather than color. The only exception are very small children (1 − 2 years) who focus on colors rather than on shapes (because of scarce knowledge about objects). Naming the colors of abstract shapes (not real objects) was easier for children due to lower interference as an ambiguous shape cannot be classified so easily as a real object to its kind. Further research in this field of Heij, Boelens and Kuipers [8] reported in the group of 5 − 7 year olds

that naming an object's color was facilitated when a color name and object name are phonologically similar (e.g. red rat).

The multitude of theoretical backgrounds and measures of interference control is worth appreciation as it may be analyzed in many different directions. However, Naomi Friedman and Akira Miyake [7], the head researchers on this field notice that these outcomes strongly hinder comparisons between the results obtained in different research and discussing interference *per se*. It is a consequence of several important issues. First one is that authors discuss interference control in different theoretical and methodological backgrounds. Consequently, different measures addressed to assess interference control are administered in research. Each task has its idiosyncratic and specific demands and puts attention to different types and number of stimuli (e.g. common objects/ fruits/abstract shapes). The administration procedure (paper/PC) is also different in each task. It leads to different ways of scoring and theoretical interpretation of results. Similarities and differences between tasks can be however a fruitful area of future research. The last problem which arises in research is the «impurity of tasks» as they often measure also other processes (e.g. working memory, mental flexibility).

Characterisics of author's project

The aim of the project is the preparation of set of tasks and devise its psychometric properties. Most of studies, including in children, examined interference in only one direction (word-reading interferes with color naming; the size of a drawing of an animal interferes with deciding its real size). However, interference can occur in two directions (reverse Stroop effect, depicted in 1935 by himself), when – as in case of pictorial animal size test [9] − the real size of an animal has to be suppressed in favor of naming the pictorial (superficial) size of an animal. Two set of task will be created in order to assess how interference occur in prereading children (task 1: naming the real size of an animal and inhibiting its pictorial size; task 2: naming the pictorial size and inhibiting its real size). In which set of tasks interference control is stronger? The project's tasks will enable to make such comparisons. After the first pilot set of tasks, it will be assessed by competent judges. Modifications will be made before research among polish preschoolers. After pilot studies in kindergartens the analysis of the reliability will be scored. Unfortunately there is no standardized psychological test measuring interference control in preschool children in Poland and it will not be possible to assess external validity of tasks. To circumvent this problem, interviews with parents concerning children's typical behaviors linked to interference control will be administered. Because of non-verbal material and multicultural character of tasks, it can be further used in research among foreign children.

Practical and theoretical implications of project

The importance of interference control in typical children's development is the main funding of the author's scientific project. The rediscovery of this problem in young children may represent an interesting trend in the research on inhibitory control in general and, in a wider context, become part of the current search for determinants of adaptive, goal-oriented behaviors. Theoretical implications involve broadening the so-far, yet not well structured knowledge concerning how this complex ability control develops. Giving that developmental trajectory of the motor and cognitive aspects of interference control could be different at different developmental stages, this makes it a potential target for teaching strategies which may support the development of interference control processes at different educational stages. This makes it a novel and inspiring research trend for both practitioners and theoreticians. As in case of other developmental breakthroughs proved in the literature concerning such cognitive processes as causal thinking or mental flexibility in children, it might turn out that also in case of interference control, there are sensitivity periods in acquiring this ability. Friedman and Miyake [7] highlight that researchers need to be more specific when discussing and measuring inhibition-related functions. On condition that interference control is not a homogenous set of skills, special attention should be paid here to better understanding of mechanisms of interference and conditions under which one stimuli interferes with another more or less. The motor and cognitive aspects of this complex ability should also be considered as well as reference to other parallel variables which may mediate the observed changes in interference control in children (e.g. working memory, fluid intelligence, temperament).

Conclusions

This article is a short introduction to the scientific project aimed at measurement of interference control in young children. The present review of studies reveals that vast amount of problems with children's behavior reported by kindergarten's teachers may spring from interference control deficits. Better explanation of etiology of impulsive behaviors, deficits in attention, chaotic and unpredicted behaviors of children pose a challenge for contemporary developmental psychologists and clinicians. This problem stands in a complementary relationship to the tenets of educational psychology, preschool pedagogy, forming part of the processes of education, instruction and learning. Familiarity with the problem of interference control developmental patterns helps to create suitable conditions of education and instruction which allow teachers and parents to help children to acquire adaptive and well-organized behaviors which are important both for education and socialization. Acquiring strategies to cope with distractors is important when a child should focus attention on relevant instead of irrelevant facets of different mental tasks. Effective inhibitory processes are crucial in interpersonal functioning during

problem solving, conflicts resolution and cooperation with others. It is assumed that project's results may result in theoretical justification of methodical focus on training of inhibitory processes in kindergartens, with adequate techniques and didactic methods, as well as concise instructions for the parents.

References

1. Archivald S.J., Kerns K.A. Identification and Description of New Tests of Executive Functioning in Children, *Child Neuropsychology*,1999, 5, pp. 115 – 129.

2. Alvarez J.A., Emory E. Executive function and the frontal lobes: A meta-analytic review, *Neuropsychology Review*, 2006, 16, pp. 17 – 42.

3. Bower B. Brother Stroop's enduring effect, *Science News,* 1992, 141, 19, pp. 312 – 315.

4. Catale C., Meulemans T. The Real Animal Size Test (RAST): A new measure of inhibitory control for young children, *European Journal of Psychological Assessment,* 2009, 25, 2, pp. 83 – 91.

5. Carlson S.M. Developmentally sensitive measures of executive function in preschool children, *Developmental Neuropsychology,* 2005, 28, 2, pp. 595 – 616.

6. Durgin F.H. The reverse Stroop Effect, *Psychonomic Bulletin & Review,* 2000, 7, 1, pp. 121 – 125.

7. Friedman N.P., Miyake A. The Relations Among Inhibition and Interference Control Functions: A Latent-Variable Analysis, *Journal of Experimental Psychology: General,* 2004, 133, 1, pp. 101 – 135.

8. Heij W.L., Boelens H., Kuipers J.R. Object interference in children's colour and position naming: Lexical interference or task-set competition?, *Language and Cognitive Processes,* 2010, 25, 4, pp. 568 – 588.

9. Ikeda Y., Okuzumi H., Kokobun M. Age-related trends of stroop-like interference in animal size tests in 5-to 12-year-old children and young adults, *Child Neuropsychology,* 2013, 19, 3, pp. 276 – 291.

10. Kagan J., Lemkin J. Form, color, and size in children's conceptual behavior, *Child Development,* 1961, 32, 1, pp. 25 – 28.

11. Killikelly C., Szücs D. The development of interference control: A pliot study using the manual colour word stroop paradigm, *Procedia. Social and Behavioral Sciences,* 2010, 2, pp. 4842 – 4847.

12. Kochanska G., Tjebkes T.L., Forman D.R. Children's emerging regulation of conduct: Restraint, compliance, and internalization from infancy to the second year, *Child Development,* 1998, 69, pp. 1378 – 1389.

13. Okuzumi H., Ikeda Y., Otsuka N., Saito R., Oi Y., Hirata S., Haishi K., Kokobun M. Stroop-Like Interference in the Fruit Stroop Test in Typical Development, *Psychology,* 2015, 6, pp. 643 – 649.

14. Lezak M.D. Neuropsychological Assessment (Third Edition). – New York : Oxford University Press, 1995, pp. 1 – 1000

15. Liu Q., Zhu X., Ziegler A., Shi J. The effects of inhibitory control training for preschoolers on reasoning ability and neural activity, *Scientific Reports,* 2015, 5, pp. 1 – 10.

16. Macleod C.M. Half a century of research on the Stroop effect: an integrative review, *Psychological Bulletin,* 1991, 109, pp. 163 – 203.

17. Prevor M.B., Diamond A. Color-Object Interference in Young Children. A Stroop Effect in Children $3^1/_2 - 6^1/_2$ Years Old, *Cognitive Development*, 2005, 20, pp. 256 – 278.

18. Santostefano S. Cognitive controls and exceptional states in children, *Journal of Clinical Psychology*, 1964, 20, 2, pp. 213 – 218.

19. Stroop R. Studies of interference in serial verbal reactions, *Journal of Experimental Psychology*, 1935, 18, pp. 643 – 662.

20. Siegel A.W., Vance B.J. Visual and haptic dimensional preference: A developmental study, *Developmental Psychology*, 1970, 3, 2, pp. 264 – 266.

21. Wright B.C., Wanley A. Adult's versus children's performance on the Stroop task: interference and facilitation, *British Journal of Psychology*, 2003, 94, 4, pp. 475 – 485.

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