HAND-EYE COORDINATION EVALUATED ON A SAMPLE OF CROATIAN AND POLISH FEMALE UNIVERSITY STUDENTS OF EARLY CHILDHOOD AND PRESCHOOL EDUCATION

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Abstract : The objective of the study was the analysis of measuring characteristics of the Soda Pop Test, used to evaluate hand-eye coordination on a sample of first- and second-year early childhood and preschool education female students enrolled at the Faculty of Teacher Education, branch in Petrinja (N = 55). In addition, a comparison was made of the results obtained from the sample of Croatian and Polish (N = 119) female university students with the aim to establish possible differences in test performance. The results indicated good measuring characteristics of the test thus confirming its possible implementation among university student population. Student t-test did not show any statistically significant differences between the results achieved by Croatian students as compared to those achieved by Polish students.

Key words: measuring characteristics, motor control, motor skills, Soda Pop Test.

Introduction

Hand-eye coordination is the ability needed in almost all daily activities, and it is possible that for this reason, it is not perceived as a complex action during the performance of certain motor movements. However, it is a very complex control of hand-eye coordination that requires the synergy of the nervous system in order for the eye movements to be in harmonised with hand movement or movements (Boissean, Scherzer, & Cohen, 2002). A high level of perceptual abilities is extremely important for achieving outstanding results in sports competitions (Vuk, 2010). Vidoni, Mc Carley, Edwards, and Boyd (2009) indicated in their research that the use of gaze is specific and highly dependent on the characteristics of the task to be performed. When performing a task, the eyes focus on the target before the movement of the hands, indicating that the gaze, i.e. the eyes provide spatial information for the hands (Johanson, Westling, Böckstrom, & Flanagan, 2001). The duration of target fixation required for hand movement is variable. The eyes are sometimes completely focused on the task, until the end of its performance, and sometimes the gaze explores an object before the hand begins to manipulate it (Johanson et al., 2001). The timing of gaze movement (gaze shift) in relation to hand movements in a task that requires contacting virtual objects in a horizontal plane using a handle was investigated by Bowman, Johannson, and Flanagan (2009). They were interested whether gaze movements were predictive or triggered by tactile feedback. Based on the results, they concluded that gaze movements are predictively controlled, but also time-limited, so a mismatch between the expected and actual tactile information may prompt a realignment of gaze

movements if these are performed 130 milliseconds subsequent to the contact. The ability to direct eye movements towards the hand is closely linked to a sense of proprioception with the appearance of minor errors (Ren & Crawford, 2009), which means that people with a better sense of the position of their body in space will be more successful in performing movements that require hand-eye coordination and when there is a narrowed (restricted) field of view. The relation between eye movement and hand movement in performing a rhythmic test was investigated by Lazzari, Mottet, and Vercher (2009). They confirmed that eye and hand movements are dynamically aligned during a rhythmic task for the purpose of achieving best performance. Vidoni et al. (2009) investigated oculomotor coordination and hand coordination in targeting tasks. The results showed that both systems are learned simultaneously, but performance improvements are manifested differently and depend on different elements of motor performance. Hand-eye coordination ability can be adversely affected by various factors, such as different impairments and diseases, but also by years of life (especially in precision movements), resulting in the loss of visual stimuli and their association with hand movements (Boisseau, Scherzer, & Cohen, 2002). Knowing the basics of hand-eye coordination mechanisms is very important for future early childhood and preschool teachers not only for the purpose of performing different motor movements but also for other activities dependent on this ability, such as graphomotor ability. Introducing pre-service early childhood and preschool teachers to the basics of kinesiometry and simple instruments for assessing hand-eye coordination is important for the possible construction of new measuring instruments, adaptation of the existing instruments and their application in teaching practice. The aim of this paper is therefore to introduce pre-service early childhood and preschool teachers to the Soda Pop Test measuring instrument for the assessment of hand-eye coordination, which can easily be modified for use with early childhood and preschool children, and to test its measuring characteristics. The secondary objective of this paper was to examine the possible differences in the Soda Pop Test results between pre-service early childhood and preschool education female teachers enrolled at the University of Zagreb Faculty of Teacher Education, branch in Petrinja and female students enrolled at the University of Kielce Faculty of Wydzial Pedagogiczny and Prtystyczny, Poland.

Methods

Sample

A total of 174 first- and second-year early childhood and preschool education female university students from Croatia and Poland participated in the research. The number of students enrolled at the University of Zagreb Faculty of Teacher Education, branch in Petrinja was N = 55, and the number of Polish students enrolled at the University of Kielce Faculty of Wydzial Pedagogiczny i Prtystyczny was N=119.

Measure: Soda Pop Test

The Soda Pop Test is a manual dexterity test or coordination test of fine motor abilities, which involves turning over cans. The purpose of this test is to measure manual dexterity and hand-eye coordination. The full description of the test on:
https://www.topendsports.com/ testing/tests/soda-pop.htm)

Statistical analysis

The analysis and data processing was done using the computer program Statistica 13.5

Procedure

The test was implemented during October 2019. The participants performed the test with their dominant hand and they had one trial attempt prior to testing. For the purpose of testing its

measuring characteristics, in this research the Soda Pop Test was performed with three repetitions with female students in Petrinja so that its factor structure could be analysed.

Results

Table 1
Descriptive parameters of the Soda Pop Test – students of the University of Zagreb Faculty of Teacher Education, branch in Petrinja (N=55)

Variables	M	Min	Max	SD	K-S
Soda Pop Test – dominant hand 1	8.99	6.93	14.96	1.37	p > .20
Soda Pop Test – dominant hand 2	8.38	6.52	12.58	1.15	p > .20
Soda Pop Test – dominant hand 3	8.29	6.42	12.23	1.11	p > .20

Legend: mean (M), minimum (Min) and maximum (Max) result, standard deviation (SD), Kolmogorov – Smirnov test (K – S)

Average results of the dominant hand in all three repetitions had very similar values. By repeating the test, the results were improved. The values obtained for other descriptive parameters were similar. The smallest dispersion of results, and hence its highest homogeneity, was achieved during the third series, which may indicate that the number of repetitions has a positive effect on the values of the results. The distribution of results was normal for all three attempts.

Measuring characteristics of the Soda Pop Test

Table 2
Reliability of the Soda Pop Test items

	I T C	S M C	α
Soda Pop Test, Dominant hand 1	0.73	0.57	0.87
Soda Pop Test, Dominant hand 2	0.85	0.72	0.75
Soda Pop Test, Dominant hand 3	0.73	0.60	0.85
Cronbach Alpha (Cα)			0.88
Average inter-item correlation			0.72

Legend: Item Total Correlation (ITC), coefficient of determination (SMC), coefficient alpha if deleted (α)

The correlation values of individual items with other items are very satisfactory and range from 0.73 to 0.85. The values of the coefficient of determination indicate the existence of a common object of measurement, and alpha coefficient, after individual item deletion, contributes equally to the reliability of the test with its high values. The internal reliability coefficient of the test - Cronbach alpha (Cα) is very high (0.88) as is the value of the average test item correlation (0.72), which indicates satisfactory reliability of the Soda Pop Test in this sample.

Table 3
Principal components

	(L)	%	cum %
1	2.43	80.97	80.97

Legend: Eigenvalue (L), percentage of explained variance matrix of items **(%)**, cumulative percentage of variance (cum %)

Factor analysis of the test items yielded one characteristic root that carries more than 80% of the total variance value of the item inter-correlation matrix. The isolated factor indicates the existence of a common measurement item.

Table 4
Factor loadings (Varimax normalized)

Soda Pop Test	Item number Soda Pop Test	Factor
	1	-0.88
	2	-0.94
	3	-0.88

The values of the items projected on the factor show a very high factor saturation. On the basis of the presented results, it can be concluded that the factor structure corresponds to the hand-eye coordination factor, so the extracted factor can also be called hand-eye coordination (F1).

Differences in the values of the results of the Soda Pop Test between Polish and Croatian female university students

The average Soda Pop Test scores of Polish and Croatian female university students are almost identical regardless of the difference in the number of participants.

Table 5
Descriptive Statistics - the sample of Polish and Croatian female university students

Variable	N	M	Mdn	Min	Max	SD	K – S
Soda Pop Test - Poland	119	8.411	8.210	6.080	14.090	1.290	p < .10
Soda Pop Test - Croatia	55	8.257	8.200	6.520	12.580	1.098	p > .20

Legend: mean (M), median (Mdn), minimum (Min) and maximum (Max) results, standard deviation (SD), Kolmogorov – Smirnov test (K – S)

Similar values were also observed for other descriptive parameters in both groups. Such values of the results show that there probably are no significant differences between Croatian and Polish female university students, which was verified by student t-test.

Table 6
T-test for Independent Samples - Croatian and Polish female university students

	M (N=119) Poland	M (N = 55) Croatia	t	df	p
Soda Pop Test - Poland vs. Soda Pop Test - Croatia	8.411	8.257	0.766	172	0.445

Legend: mean (M), t value (t), degrees of freedom (df), coefficient of significance (p)

As mentioned earlier, given the quantitative similarity of the obtained results, t - test results did not show significant differences between Croatian and Polish female university students on the Soda Pop test, which assessed hand-eye coordination.

Discussion

Hand-eye coordination is a specific type of coordination that plays an important role in people's daily activities. In addition, the importance of hand-eye coordination has been confirmed in a number of sports such as tennis (Kulušić, Marković, & Novak, 2011), handball (Lorger, Kunješić, & Mraković, 2016), basketball (Lješević & Kvesić Tomaško, 2016) and other ball sports where appropriate estimate of the ball flight and good hand manipulation of the ball, whether it be dribbling or hitting the target, in connection to the speed factor can be one of the basic elements of winning. Successful execution of motor structures that depend on hand-eye coordination requires a high level of precision and a sense of space and time (Sekulić & Metikoš, 2007).The results obtained in this study, to the authors' knowledge, could only be compared with those of a study conducted with forty elementary school students M = 10.4 (Who, 2017), where the author characterized the Soda Pop Test as a "cognitive function test". The mean results obtained in

this measurement with the dominant hand are significantly better (M = 8.411, Poland and M=8.257, Croatia) than the results obtained in the abovementioned study. This is understandable because there is a noticeable difference in age, which implies certain motor experience and the maturation of some cognitive functions on the part of female university students. Confirmation of such categorization is the fact that the sensory-perceptual system, and primarily visual abilities, are the first to participate in cognitive processing of information, with the reaction time relying on central vision being shorter than the reaction time where peripheral vision prevails (Brebner & Welford, 1980, as cited in Zanini, Trivić, & Drid, 2011). Reaction time is related to movement control and is an indicator of the speed of mental operations required in task completion (Kosinski, 2009,Luce, 1986; Weldorf, 1980, as cited in Jeronem, Barić, & Kajtna, 2010). The response time to the stimulus is faster if there is only one possible response, and slower if there are multiple response options (Schmidt & Wrisberg, 2000, as cited in Jeronem et al., 2010). Data analysis showed that success of the test performance increases with the number of repetitions (Table 1), which could be a consequence of motor learning, or better motor control of movement. It can also be a consequence of focusing attention, which can be active (concentration) and requires greater level of mental effort, both passive and non-directional (Brebner & Welford, 1980, as cited in Zanini, Trivić, & Drid, 2011). Assessment of the metric characteristics of the Soda Pop Test on a sample of female university students of the Faculty of Teacher Education showed very satisfactory properties of the test. Reliability analysis yielded high values of the Soda Pop Test reliability coefficients as well as high average correlation between test items. The projections of item values onto the factor are also extremely high, which means that the extracted factor estimates the desired object of measurement in this hand-eye coordination study. Perhaps this hand-eye coordination test should also be applied more frequently with the younger population in order to test its metric properties for a possible practical application and creation of a database which could be used for comparisons of study results on the basis of the participants' age.

Conclusion

The applied Soda Pop Test in this study showed very satisfactory metric properties, both in item reliability and in internal reliability, therefore it is suitable for practical application. In the factor analysis one factor was extracted: hand-eye coordination. Student t - test did not confirm significant differences between Croatian and Polish female university students. In order for the test to be applied in practice with children, elementary and secondary school students, and for a database to be created, it is necessary to additionally assess its measuring characteristics on a younger and sufficiently large sample of respondents.

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