


KINEMATIC CHARACTERISTICS OF MOVEMENT ON A TOUCHSCREEN REPRESENTATION OF A VIRTUAL OBJECT AS PREDICTORS OF ITS MENTAL IMAGE IN PRESCHOOLERS

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RESEARCH OBJECTIVES

General objective : To find objective correlatives of mental image characteristics of a virtual object in preschoolers using computer applications

Specific objective : Identification of differences in the kinematic characteristics of the movement of a virtual object between groups of preschoolers who identify a virtual object as "light" or "heavy"

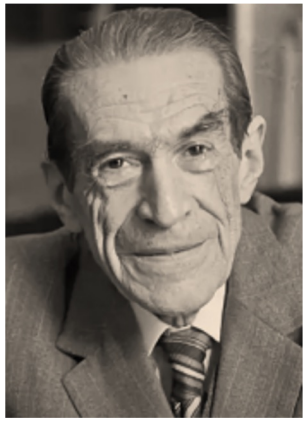
THE WEIGHT OF A VIRTUAL OBJECT AS A SUBJECT OF PSYCHOLOGICAL RESEARCH

Rationale:

1) possibility of actions with virtual objects (the interaction experience is generalized in the form of sensorimotor memory, implicitly including information about the object's weight);

2) «virtual synesthesia» – haptic (touch) illusion: visual stimulation without haptic feedback in VR can induce an involuntary experience in an additional sensory pathway (haptic or heat sensations) (*Aymerich-Franch et al., 2017; Weir et al., 2013*).

KINEMATIC CHARACTERISTICS AS CORRELATIVES OF MENTAL IMAGE



- A.N. Leontiev's activity theory framework about the active role of the mental image in the regulation of actions
- «*mental image - action - more developed mental image*» scheme, according to which task execution is modulated by the mental image of the context (Smirnov S.D., 1994)
- N.A. Bernstein's idea of exploring movements as an indicator of processes in the central nervous system

PARTICIPANTS

18 typically developing children (9 boys, 9 girls) from 3,58 to 4,75 years old (M_{age} = 4,16 years, SD = 0,38).

EXPERIMENTAL PROCEDURE

I. Operationalization of the object's weight through the location on the model of the hill (non-verbal weight task (*Kloos et al., 2002*))

II. Execution of the instruction «Put the cube on the shelf» on a tablet PC (3 trials), including recording the coordinates of the moving cube

III. Choosing a location on a hill model for a virtual object by a child (identifying a virtual object as light or heavy)

IV. Analysis of the kinematic profiles of children who identified the virtual cube as light or heavy

I.OPERATIONALIZATION OF THE OBJECT'S WEIGHT

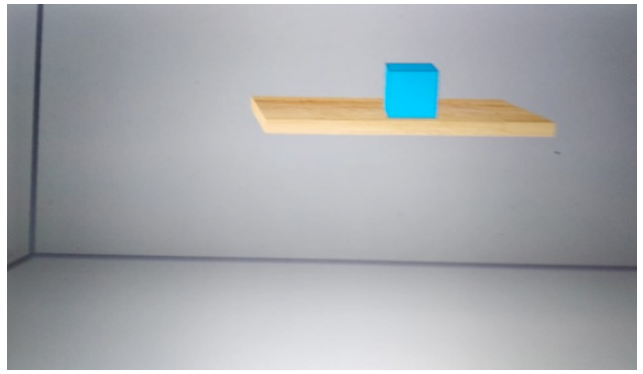
through the location on the model of the hill

non-verbal weight task (Kloos et al., 2002)

II. EXECUTION OF THE INSTRUCTION "PUT THE CUBE ON THE SHELF" ON A TABLET PC (3 TRIALS)

- a computer application that simulates the action of lifting a 3D virtual object (cube) onto a shelf (the children were asked to "put the cube on the shelf")

- the simulated action belongs to the level D (complex motor performances) in the model of motor control by N.A. Bernstein



RECORDING THE COORDINATES OF THE MOVING CUBE

x	y	time	timeNormal
0	0	10	0m0s.10ms
0	0	20	0m0s.20ms
0	0	30	0m0s.30ms
0	0	40	0m0s.40ms
0	0	50	0m0s.50ms
0	0	60	0m0s.60ms
5	5	70	0m0s.70ms
17	15	80	0m0s.80ms
17	15	90	0m0s.90ms
37	27	100	0m0s.100ms
37	27	110	0m0s.110ms
63	39	120	0m0s.120ms
90	53	130	0m0s.130ms
90	53	140	0m0s.140ms
121	67	150	0m0s.150ms
121	67	160	0m0s.160ms
154	82	170	0m0s.170ms
194	98	180	0m0s.180ms
194	98	190	0m0s.190ms
234	115	200	0m0s.200ms
234	115	210	0m0s.210ms
277	134	220	0m0s.220ms
321	154	230	0m0s.230ms
321	154	240	0m0s.240ms
363	175	250	0m0s.250ms
363	175	260	0m0s.260ms
405	198	270	0m0s.270ms
445	220	280	0m0s.280ms
445	220	290	0m0s.290ms

- a computer program that captures the linear coordinates of a 3D virtual object as it moves every 0.01 sec

III. CHOOSING A LOCATION ON A HILL MODEL FOR A VIRTUAL OBJECT BY A CHILD (identifying a virtual object as light or heavy)

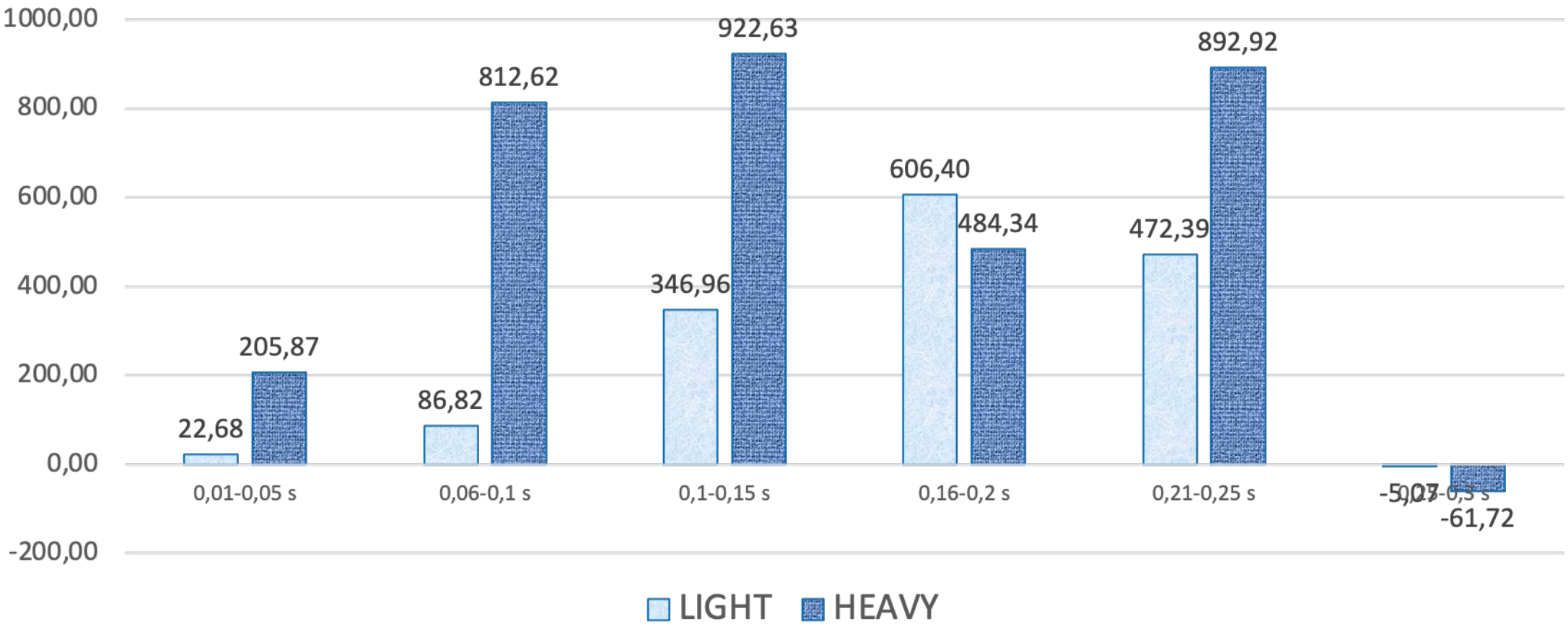
NUMBER OF CHILDREN	REAL CUBE LOCATION (CM)		VIRTUAL CUBE LOCATION (CM)
	HEAVY	LIGHT	
14 (78%)	8,5	40	40
4 (22%)	15	40	13,25

RESEARCH HYPOTHESIS

We hypothesized that the repetition of lifting on the shelf forms a sensorimotor experience that determines the identification of the virtual cube as light or heavy and regulates the displacement of the cube.

Children who find the virtual cube heavy will put more force in the initial phase of moving the cube, resulting in greater acceleration.

ACCELERATION OF DISPLACEMENT OF A VIRTUAL OBJECT
(MEDIAN VALUE), MM/S²



ACCELERATION OF DISPLACEMENT OF A VIRTUAL OBJECT (MEDIAN VALUE), MM/S²

Time interval from the start of cube displacement	Virtual cube identification by weight		Mann-Whitney test
	HEAVY	LIGHT	
0,01-0,05 s	205,87	22,68	U_{emp}= 6, p≤0.01
0,06-0,1 s	812,62	86,82	U_{emp}= 8, p≤0.05

CONCLUSIONS

- The results obtained do not allow us to make an unambiguous conclusion regarding the possibility of using the kinematic characteristics of the displacement of a virtual object as objective predictors of preschoolers' ideas about the weight of this object.
- A limitation for a valid conclusion is the high intra- and inter-individual variability of kinematic characteristics, which may reflect the immaturity of motor control in children under 5 years of age.
- It also requires testing the ability of preschoolers to estimate the weight of an object based on the information obtained when it is moved (using real objects).

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УРАЛЬСКИЙ ГОСУДАРСТВЕННЫЙ ПЕДАГОГИЧЕСКИЙ УНИВЕРСИТЕТ

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