Self-Regulation in Performing Handstand

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Abstract
The aim of this research is to analyse the different representational levels reached both by elite/non-elite gymnastics with different levels of experience when performing a specific motor task (handstand). We will be focusing specifically on how these representations become more explicit and conscious as the development process takes place. These increasing levels of awareness will allow the subjects of our study to have greater control over their actions. The relationship between awareness and motor learning is a question that has not drawn much attention so far, but it is essential from both, a theoretical and a practical point of view. Indeed, our interest in this issue springs out not only from psychological concerns but also from our connection with teaching and learning of Sport.

Keywords: Representational levels; Awareness; Explicitness; Handstand


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Introduction

This paper aims to analyse the different levels of thought processes involved in performing handstand, in order to establish the different stages in the organisation and acquisition of such behaviour, which is a reflection of the self-regulation process in actions. We would like to highlight how motor actions are directly or indirectly controlled by a cognitive process - which may be conscious or unconscious-, where the main issue would be to establish the level of individuals' awareness of a specific task and the control, they exert over it. That is, we are wondering with Lacasa & Villuendas [1], to which extend cross-regulation and feedback processes occur between the action itself and its representation.

We refer to these processes by the term "self-regulation". According to Richard [2], control mechanisms result in performance strategies, which respond both to a hierarchical component and to an interactive one, which connects the previous component to assessment outcome, memory systems and information processing. Action regulation will occur with the building of representations and the system of re-questioning the performance framework and the process chosen, which will allow us to
establish different levels of awareness. Piaget [3], following Claparède and his theory of awareness, establishes different levels based on the conception of consciousness as a typical feature of human beings. Moreno [4], points out that consciousness is at first guided by automatic processes caused by external stimuli, until it gradually acquires a greater control over and a better explanation of its own behaviour. Taking this premise as the starting point, it logically follows that the awareness process will favour self-organisation [5], a term which we consider similar to self-regulation.

Thus, these are the questions we are trying to answer in this paper: what strategies could favour self-regulation of the motor action in the awareness process? Another question to consider is the degree of difficulty in the specific motor task, when the child does not achieve the objective in spite of his/her effort. We feel that the motor task of handstand - performed without any kind of support or outside help - has an added difficulty for the subjects of our research. That is, the child will have to anticipate and perform the task free from conflicts and to justify his/her final performance. Finally, we must bear in mind all the different aspects of the action not considered by the child, in order to explain the incidence of handstand in learning and motor development.

Regulation of the awareness process will be encouraged by metacognitive knowledge, when the child makes the representation of the action explicit by applying tasks we will be describing shortly. This process will allow the child to reorganise his/her knowledge to enable him/her to solve the problem formulated at an explicit level and to approach the proposed objective at a practical level. Following Karmiloff-Smith's theory [6], we plan to analyse the self-regulatory process by which the subject achieves a specific objective within the context of a given task. In this reorganisation of knowledge, the Piagetian notion of schema (which relates action to representation) is an important concept of analysis as well as Rossum [7], Schmidt [8], Hauert [9], Berstein [10].

Zapórozhets [11] (1948/1987) has also studied how images regulate people's movements, highlighting the role language plays informing and improving voluntary movements. We understand that the control of representation over action will show itself at different levels according to age [12-14].

Method

General objectives

Analyse possible discrepancies between knowing and knowing how to do, and the hierarchy in which they occur. Also, we will try to verify the different levels of understanding depending on the evolutionary development and to analyse the genesis of the notion of handstand as a theory children build up to understand reality, and apply it when trying to perform the task.

Hypothesis

The motor task of "handstand" will answer the normal development sequence, both in its acquisition and understanding. In this sense, we shall come across different objective achievement levels depending on age and task difficulty.

We will find evolutionary differences according to age in the action representation, both in the general knowledge of the action (pre-execution) and in the specific awareness of handstand (post-execution). The subjects at the higher levels will have a well-construed theory on handstand where all the elements are interconnected. The third hypothesis shows the relationship between action and its representation: with a more elaborate theory on handstand and with a more precise awareness of their action will have better control over it.

Last hypothesis features the repercussion of training on each group: practice will provide
significant results with regards to competence levels, even at the youngest ages, equipping the subject at the same time with strategic know how by controlling and self-regulating his own action.

**Methodology**

This research incorporates parts of the correlational, psycho-genetic and observational methods.

**Participants**

This research has been carried out over 89 subjects in total. The sampling was divided into a *non-expert* group made up of 60 subjects of school age and an *expert* group made up of 29 subjects. Within this group, there are two subgroups: one is called *experts in practice* (subjects who either have been selected to become members of the Spanish Selection of Artistic Gymnastics or are current members of the National Team), the other is the group of *experts in theory* (students of Physical Education with mastery in Artistic Gymnastics, whose formal training is geared towards sports training).

The first (*non-expert*) group includes the following age-groups: 8, 10, 12, 14 and 16, with 12 subjects per age-group. The first three age-groups (8-10-12) are from a state primary school in Leganés (Madrid); the rest (14-16) are students from a state secondary school in Leganés (Madrid). Within the second (*expert*) group, the group of *experts in practice* is made up of 17 subjects between ages 8 (4), 10 (2), 12 (6), 14 (1) and 19 (4). All of them are members of the Spanish Selection of Artistic Gymnastics. On the last group (19 years) are the members of the All Male Spanish Selection, the group of *experts in theory* is made up of 12 subjects of average 24.7 years of age from the Sport Sciences (UPM), Madrid. All participants are located in middle-class areas. They volunteered for the tests and were selected at random. The reason for choosing the initial age lies in the different studies on cognitive psychology and motor development. These studies show that it is towards the age of 7-8 (concrete operation stage) when a series of changes occur in children's thoughts, reaching forms of organisation in their behaviour far above the previous ones. It is at this age when a period of qualitative transformations occur regarding thought and action [4,15-19].

Finally, we are aware of the problem posed by not being able to have a homogeneous sampling of subjects concerning number, sex and age (more specifically the *experts in practice* group). We had the advantage, however, of having a group of real experts in performance. We all know that some research of similar characteristics has been criticised because the sampling of experts does not reflect reality.

**Procedure**

Every subject had to perform a handstand and to answer a clinical interview on the task. *Performance measurement* was carried out by two judges with no part in this research who, separately and after a training period of two weeks, first viewed the practical execution of the five attempts performed by each subject; then they stopped the image at each attempt where they believed each subject had achieved the handstand; finally, they gave scores-following a fixed number scale- for each one or the selected articulation points. With those scores, a handstand representation for each subject was obtained. This was reflected on the observation sheet "MOV-API" (Movements for Inverted Supports), for each one of the attempts carried out. The *representation measurement* is made up of two parts: a) *pre-execution* at a general level, where the aim is that the subject becomes aware of the action. b) *post-execution* of a specific type, with action justification or performance revision and selection of the process performed in the last movement.

During the first part (*pre-execution*), the subject must answer the questions asked by an adult. During the second part (*post-execution*), the adult asks the subjects to explain the way they have performed the action and to represent what
they say they have done with drawings (five counterbalanced drawings are used). These drawings show the action sequence in handstand, where only their final position varies as follows: two of them do not achieve the position, one of them performs the action perfectly and the other two go past the vertical line). Finally, the subjects are asked to compare the drawing with their videoed performance.

The filming is done after the subject represents the action in general terms -first part of the clinical interview- (the subject tries to solve the problem set, in a practical way) and it is used for the second part of the clinical interview (post-execution). At the same time, once the clinical interview is over, the observation is used to fill in the form called "MOV-API", based on the descriptive study by Gallahue [17], on "Inverted Supports". For the whole procedure, an experimenter and an assistant were needed. The sessions were carried out in a schoolroom or in a laboratory of Sport Science in Madrid, where the subjects went to have the clinical interview, which was recorded, and to perform the action, which was filmed on video. The experiment was carried out in the morning, within the same timetable, i.e. between 9:30 and 13:30, to counterbalance possible circadian effects.

**Task**

We chose the motor task of *inverted supports*, where we intended to analyse the evolutionary course target achievement follows.

The test given to the subjects was introduced as follows: a) the adult asked the child questions such as: have you ever heard of handstand in your P.E classes? Do you know what it is? How would you explain it to a friend who does not know how to do it? Our aim here was that the child would anticipate what he was going to perform later. b) The adult then asked the child to perform it (can you do what you are telling me about? Would you like to show me?). The child then performed 5 attempts with a single instruction given by the adult: "put your hands on the white line marked on the mat". c) Awareness was roused with three tasks: c.1) Description of the action. The adult asked the following questions: could you tell me how you did it the last time? How did you place your hands, your head, your body, your legs and your feet? c.2) Description of the action with the help of drawings. The adult asked the child: can you find in these drawings what you did the last time? Is this drawing what you did the last time? Why? c.3) Description of the action with the help of the videoed performance. The adult would then tell the child: "pick the drawing you say it represents what you did the last time; now we are going to watch (on a video) how you did it on the last attempt and you are going to tell me if the action corresponds with the drawing you chose". After watching the video the adult would ask: does the drawing correspond with what you've done (on video)? Why? Note the situations in which awareness may take place depending on the set tasks: both child and adult anticipate the actions in handstand; the child performs the action (five attempts); describes his last action in words; selects the drawing which corresponds with what he says he has done; compares the selected drawing with the action of his last attempt as shown on video.

**Statistical criteria**

The statistical analysis main aim is to show how great the differences are among the different age groups, the expert and non-expert groups, and among the various items that make up each test. Due to the limited number of subjects per age, we have mostly used non-parametric measurements. Because our data are classified according to ordinal levels, these are the statistics we have most often used: the $\chi^2$ test, analysis of variance for rank rating by Kruskal-Wallis and the U test by Mann-Whitney. In the same way, the correlation measurement used is Spearman's Statistical significance: p. 05 (*), p. 01 (**) and p. 001 (***).
Results

Our aim is to analyse the repercussion and scope of the intervention process (general scheme of the action, its development and its conceptualisation) throughout our research. Table 1 gives details of the total variables making up the procedure applied to the subjects.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Intervention process</th>
</tr>
</thead>
<tbody>
<tr>
<td>General knowledge of the task</td>
<td>Interview: First part</td>
</tr>
<tr>
<td>Knowledge of the self-regulation needed</td>
<td>(Anticipation or pre-execution)</td>
</tr>
<tr>
<td>Performance strategy</td>
<td>Interview: Second part</td>
</tr>
<tr>
<td>5th attempt</td>
<td>Conceptualisation</td>
</tr>
<tr>
<td>Verbal explanation</td>
<td>(Awareness or post-execution)</td>
</tr>
<tr>
<td>Drawing recognition</td>
<td></td>
</tr>
<tr>
<td>Recognition of last videoed performance</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Variables of the procedure applied to the subjects.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Knowledge</th>
<th>Self-regul.</th>
<th>Strategy</th>
<th>5th attempt</th>
<th>Verbalisa.</th>
<th>Drawings</th>
<th>Video</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>1.00</td>
<td>0.729**</td>
<td>0.757**</td>
<td>0.594**</td>
<td>0.573**</td>
<td>0.524**</td>
<td>0.510**</td>
</tr>
<tr>
<td>Self-regul.</td>
<td>0.729**</td>
<td>1.00</td>
<td>0.768**</td>
<td>0.584**</td>
<td>0.667**</td>
<td>0.607**</td>
<td>0.571**</td>
</tr>
<tr>
<td>Strategy</td>
<td>0.757**</td>
<td>0.768**</td>
<td>1.00</td>
<td>0.657**</td>
<td>0.638**</td>
<td>0.528**</td>
<td>0.520**</td>
</tr>
<tr>
<td>5th attempt</td>
<td>0.594**</td>
<td>0.584**</td>
<td>0.657**</td>
<td>1.00</td>
<td>0.553**</td>
<td>0.487**</td>
<td>0.473**</td>
</tr>
<tr>
<td>Verbalisa.</td>
<td>0.573**</td>
<td>0.667**</td>
<td>0.638**</td>
<td>0.553**</td>
<td>1.00</td>
<td>0.815**</td>
<td>0.595**</td>
</tr>
<tr>
<td>Drawings</td>
<td>0.524**</td>
<td>0.607**</td>
<td>0.528**</td>
<td>0.487**</td>
<td>0.815**</td>
<td>1.00</td>
<td>0.662**</td>
</tr>
<tr>
<td>Video</td>
<td>0.510**</td>
<td>0.571**</td>
<td>0.520**</td>
<td>0.473**</td>
<td>0.595**</td>
<td>0.662**</td>
<td>1.00</td>
</tr>
</tbody>
</table>

General analysis of the process variables: With the variables shown on the table above, we worked out the rank order correlation coefficient by Spearman and these were the results for the whole sampling (Table 2):

Table 2: Spearman's correlation coefficient n=89

Correlation is significant at level 0.01 (bilateral). These results indicate a strong positive association between each of the variables. The highest correlation occurs between "verbalisation"-"drawings" (0.815**), at the individual level. As for the groups, those making up the action general scheme ("knowledge" "self-regulation" and "strategy") stand out. Considering age: within the non-expert group, the 8 year one correlates positively "knowledge"-"video" (0.819**) and "5th attempt"-"strategy"(0.721**). The 10 year one, "verbalisation"-"self-regulation" (0.605*), "video"-"self-regulation" (0.649*), “drawings”-"verbalisation" (0.631*), “video”-“verbalisation” (0.792**) and “video”-“drawings” (0.658*). At 12, “drawings”-“verbalisation” (0.693*). At 14, "self-regulation"-"verbalisation" (0.609*). At 16, “verbalisation”-“drawings” (0.823**). Within the expert group, at 12, “verbalisation”-“drawings” (0.953**); within the Exp-T group, “verbalisation”-“drawings” (0.731**). No significant correlation is observed in the other groups. When comparing between groups (non-expert/expert), correlation is as follows (Table 3):
Table 3: Spearman's correlation coefficient n=53.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledg.</td>
<td>1.000</td>
<td>0.817**</td>
<td>0.785**</td>
<td>0.575**</td>
<td>0.567**</td>
<td>0.508**</td>
<td>0.545**</td>
</tr>
<tr>
<td>Self-regul.</td>
<td>0.817**</td>
<td>1.000</td>
<td>0.828**</td>
<td>0.574**</td>
<td>0.679**</td>
<td>0.639**</td>
<td>0.551**</td>
</tr>
<tr>
<td>Strategy</td>
<td>0.785**</td>
<td>0.828**</td>
<td>1.000</td>
<td>0.617**</td>
<td>0.613**</td>
<td>0.515**</td>
<td>0.474**</td>
</tr>
<tr>
<td>5th attempt</td>
<td>0.575**</td>
<td>0.574**</td>
<td>0.617**</td>
<td>1.000</td>
<td>0.584**</td>
<td>0.576**</td>
<td>0.511**</td>
</tr>
<tr>
<td>Verbalisa.</td>
<td>0.567**</td>
<td>0.679**</td>
<td>0.613**</td>
<td>0.584**</td>
<td>1.000</td>
<td>0.830**</td>
<td>0.544**</td>
</tr>
<tr>
<td>Drawings</td>
<td>0.508**</td>
<td>0.639**</td>
<td>0.515**</td>
<td>0.576**</td>
<td>0.830**</td>
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<td>0.699**</td>
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<tr>
<td>Video</td>
<td>0.545**</td>
<td>0.551**</td>
<td>0.474**</td>
<td>0.511**</td>
<td>0.544**</td>
<td>0.699**</td>
<td>1.000</td>
</tr>
</tbody>
</table>

The degree of significance is again 0.001 (bilateral). The results confirm what was noted for n=89: high correlation between "verbalisation" and "drawings" (0.830**) and per group, correlation among the three variables of the action general scheme.

Overall procedure: If we convert the set of variables that make up the action general scheme and the conceptualisation (first and second part of the interview) into two variables respectively, and we relate them with performance, we will get a correlation significant to level 0.001 (bilateral). The correlation results show that the highest level of association occurs between "action general scheme"-"conceptualisation", action general scheme"-"5th attempt" and, finally, "conceptualization"-"5th attempt" (table 4).

Table 4: Spearman's correlation coefficient n=89.

<table>
<thead>
<tr>
<th></th>
<th>Action gen. scheme</th>
<th>5th attempt</th>
<th>Conceptualisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Action gen. scheme</td>
<td>1.000</td>
<td>0.632**</td>
<td>0.678**</td>
</tr>
<tr>
<td>5th attempt</td>
<td>0.632**</td>
<td>1.000</td>
<td>0.564**</td>
</tr>
<tr>
<td>Conceptualisation</td>
<td>0.678**</td>
<td>0.564**</td>
<td>1.000</td>
</tr>
</tbody>
</table>

Discussion

The variables got the highest scores for all the sampling, bearing in mind the different tests taking place in the process -i.e. action development, performance strategy and recognition of videoed performance-. Concerning action general scheme, the best success is for strategy, knowledge of necessary self-regulation and general knowledge of task; and for conceptualisation, it is recognition of videoed performance, recognition of drawings and verbal explanation. Per group, the three variables that make up anticipation or pre-execution improve with age. Notice how, for the youngest schoolchildren -8 to 10 year olds in the non-expert group- general knowledge of the task, self-regulation and strategic behaviour turn out to be less difficult. This relationship reverses with age (12-16). Within the expert group, strategy and knowledge of necessary self-regulation (variables directly linked with practice) get the highest scores right from the beginning. For the whole sampling, from eight year olds, recognition of the videoed performance is easier than drawing recognition and verbal explanation. Note how conceptualisation and practice improve with age, even though the difference in practice is less significant. The training factor marks the disparity between the two groups (trained/not trained): the higher the level of training the more predominant strategy is to the detriment of knowledge. Correlation is significant among the variables from the general scheme of...
knowledge and, per age group, among the conceptualisation variables.

In general, that action is ahead of conceptualisation and action general scheme of knowledge for the groups with no experience, except for the 8-year-old group, where general scheme of knowledge is ahead of conceptualisation with little representative average. In this sense, from 10 to 16, awareness is ahead of general scheme of knowledge, and it increases with age. We can infer from this that it is important to work on the development of awareness for motor actions classed by Sáenz-López [20] as global -they involve the whole body [21]; closed -since the context is known and stable (Poultron, 1957)-; habitual -their movement sequence is known and becomes automated (Knapp, 1963)-; self-regulated -closed habitual motor tasks [22], and discreet -their movement has a beginning and an end and, once the action is initiated, it is difficult to modify it (Fitts and Posner, 1968). This way the subject can draw up the action general scheme of knowledge. We have noted, however, that general scheme of knowledge is ahead of the action, and ahead of conceptualisation for all ages in groups with a high level of execution. Therefore, the kind of work required for these groups also focuses on the development of awareness so that the representation after performance coincides with the action itself. The apparent gap in awareness could be because elite athletes adapt technique to their personal characteristics depending on performance (in our particular case, it means to stay longer on handstand, and to do so they go slightly over the vertical line). Because of this, their answers after performance do not objectively correspond to their behaviour.

According to the results, awareness favours the drawing-up of a general scheme of organised knowledge for all ages and, for those groups with experience, it helps to make representation after execution coincide with the action itself [4-6,13,14,23].

Conclusion

1. We found differences between the action itself and the action general scheme of knowledge and conceptualisation. At the same time, there has been a gap between the solution and the understanding of the task in the process development.
2. The self-regulation of behaviour with the information gathered from outside is less complex than becoming aware of the interaction we establish with the object.
3. We have found three fundamental phases in development. First phase, there is no awareness of the action itself, achieving the appropriate result is paramount, and priority is given to the information coming from external stimuli. Methods of solution are disorganised, patterns of behaviour are repeated with no reflexive process. During the second phase, the subjects gradually become aware of their movements, there is an initial conscious control of the task and the performance strategy is planned within their possibilities, bearing in mind the aim and the means to achieve it. Depending on the outcome from their behaviour, they generate a rule of specific performance for each specific case, where the first stages of space-temporal perceptions can be observed. During the third phase, we have noted that the subjects are able to perform coordination between observables, characterised by exact control over every part of the body involved in the action. Awareness and progress in the knowledge of the causes for performance produces a kind of balance between the internal and the external world, generating flexible schemes capable of integrating new elements without breaking the balance.
4. In the behaviour self-regulation process we understand the building-up of coordination in the action general scheme of knowledge, its development and conceptualisation.
5. The differences found between achieving the objective and conceptualising the action are due to the instructional factor. These differences could be overcome with the teaching of those concepts, although it is true that there are many other concepts.
6. Cognitive representations can control motor activities to different degrees, and that it would be necessary to establish whether it is easier for the child to build representations of his body in movement taking it as a whole or rather as a set of isolated elements that have to be controlled and mastered independently. We feel that both the tasks features and the subjects' experience will set the differences.

7. This study has made us realise that self-regulation of the action through awareness helps to achieve success in the task.

Acknowledgement

We thank the Spanish elite gymnastics managers' for their support in carrying out this study, and the people for accepting to participate in this research.

References