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Evaluation of the Autistic Children Motor Skills: A Research Project Proposal

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Abstract

Imitation is considered as a platform for interdisciplinary studies where social sciences, cognitive psychology, neurobiology and neurocybernetics interact, as well as clinical psychology. It is often used to explore various and several scientific fields but few works have investigated a series of linked successive motor actions. The current work aimed to study and expand the findings regarding which information subjects of different populations selected and included for reproducing demonstrated model actions. 120 children of 6 age groups divided between 3 years and 8 years, associated to autistic and deficient children were tested in this present study. This developmental scale completed, should provide a baseline for understanding in what type of constraints the autistic child would be specifically deficient in the management of his imitation. The comparison with mentally deficient children also seemed indispensable. The children's imitative responses were videotaped, coded in dichotomy data, and then put into percentage. Our expected goal is to characterize the traits of autistic motor skills in reference to normal and mentally deficient development.

Keywords: Autism; Preschool and school children; Successive linked motor actions; Perception-action matching; Imitative conditions; Development

Introduction

The behavioral disorders of the autistic children deeply and essentially concern the interpersonal and social communication and understanding skills [1-6]. These relationship disorders can take the form of a trait, indifference and even behavioral quirks [7]. Language deficiencies, according to children, range from mere delay to total mutism; where the pragmatic use of language is mainly affected [8-11].

It is also demonstrated a qualitative impairment of imagination in autistic children [12-16] and an inability to understand the implicit constraints of relational situations [17,18]. These children with autism spectrum disorder are also considered anxious, with a restricted repertoire of often stereotyped and ritualized activities [19-21] and they possess incongrated interests. Those possess were believed to dislike the change that they can respond to by emotional reactions [22-25] or even self-mutilating [26]. Others Symptoms in autism concern the neurodevelopmental disorder, appearing in early age. Research consensus shows impairment in joint attention (the capacity to intentionally share attention between two persons or a person and an object) [18].

For a long time, the psychoanalytic discourse was the only dominant one, which guiding the educational and therapeutic behaviors of the autistic children [27]. This theoretical hegemonic was above all prevailing at the level of the institutional discourse. However, it had significant practical implications. In this interpretative framework, the most commonly advanced origin is that of a bankruptcy of early relational appointments of the young child with his family environment that would fundamentally handicap all subsequent relationships [4]. The assumption was predominantly focused on the problem of relational rehabilitation, thanks to psychoanalytic methodologies adapted to children deprived of language expression.

However, for the last twenty years, other interpretations were established based on clinical observations coupled with experimental approaches. These interpretations also come to enlighten autistic disorders according to the biological arguments: perceptive thresholding disorder [28-34], defection of inter-sensory binding [35,36], deficiency of the habituation mechanism [37-39], dysfunction of executive functions [40-42] and metabolic disorders [43,44]. Moreover, and parallel to these approaches assuming as a primary cause, a dysfunction of the nervous system, methods of psychology revealed that autistic children would have a bad theory of mind (ToM) [45-51] and probably difficulties to imitate [41,52]. Thus, other types of more pragmatic pedagogical support were emerging, often in opposition to the former.

Motor impairments are fundamental aspects of autism spectrum disorder (ASD) [4]. Since motor skills underpin social and cognitive development, understanding and treating these impairments could be a new and important target for developing early interventions [17]. Autistic children have impaired performances in skilled motor gestures [53,54], motor coordination and motor imitation [55]. These motor problems are associated with a disruption in postural control abilities with meaningful sways and variability in posture and atypicalities in motor control (kinematics) manifested by jerkier and less accurate movements [55,56].

Studies indicated an association between poor postural control and impairments in sensory inputs including proprioceptive feedback [57]. Internal models of action rely on coupling action and perception [29]. From now on impairments in motor control in autism could be linked to abnormalities in the processes underlying the formation of these models, including an integration weakness between external and proprioceptive inputs [36]. It was showed that behavioral variability in motor control accompany disrupted patterns of proprioceptive sensory

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feedback [4,5].

It is probably not yet the time of a consensual conception of a general framework, in which various, different and complementary theories would be integrated into a seamless continuum of knowledge. However, advances in cognitive sciences [53,58] suggest hope, that it would become possible to think together, of the approaches hitherto reflected through the theoretical plural and independent prisms. This hope is based on two facts. On the one hand, these young sciences attempt to link the behavioral level, observed by psychologists, to more internal explanatory scales, invested until then by the only biologists: neural, chemical, or even genetic [59-61]. On the other hand, technological advances offer researchers, non-invasive investigative means such as cerebral imagery, allowing for the first time, that scientific formalizations take as their object the links between the mind, behavior and brain [62-65].

A fundamental developmental task for children is to learn the objects, causal relations and customs of their culture and to acquire competency with associated skills. A great deal of this is achieved through observation and imitation of more knowledgeable others [66,67]. By three to four years of age, children can imitate cognitive, rule-based events on social observation [68-70] and they can imitate hierarchical structure in action [71-73]. Children's imitative prowess is one hallmark of human cognition in comparison in other primate [74]. Hard, Recchia and Tversky found that observers who engaged in more online hierarchical processing of action events had a more organized and robust memory for the events and their temporal order [75].

Indeed, temporal order plays a significant role in action processing in infants and adults [76-78]. The order in which actions are executed is often causally relevant (e.g., plugging in a machine before using it); and even when violations of order [79-82] and they can imitate hierarchical structure in action. The children's imitative prowess is one hallmark of human cognition compared to other primates [74].

The practitioner concerned with the motor education of the autistic child, has not yet really benefited from the contributions of these young cognisciences. The only real gain of scientific evolutions and with them, mutations in the consideration of autism, lies in a triple conviction

(i) To abandon any theoretical bigoism

(ii) To base the pedagogical support on observation and

(iii) To enrich the understanding of the terrain by scientifically based data. Our project is a part of this triple conviction. It proposes to be interested in the motor skills of the autistic children, through the study of their imitative behaviors. It gives itself as a comparative purpose of analysis to standard children with typical development and mentally deficient children, the specific deficits of autistic motor skills.

This study choice is motivated by several reasons

One is explained by the fact that imitation is typically a subject of study until then approached by several scientific fields and that the cognisciences begin to invest in their turn [83-87]. The construction of copycat robots [3], the concordances in the imaging of a brain that observes or imitates, the existence of mirror neurons system [88,99] are all tracks that constrain to re-reflect the ability analyzed by psychologists, to translate a perception visual movement as well as the ability and the others are animated by intentions [55].

Following the discovery of this particular class of visuo-motor neurons, several neuroimaging studies have provided evidence for the existence of a mirror neuron system in human [95-100] involving Broca's area (the human homologue of monkey area F5) and the intraparietal sulcus (IPS) during action observation. The mentalizing and mirror systems are thought to play important roles in inferring the internal mental states of others – a process known as mentalizing. Autism spectrum disorder is indeed associated with difficulties in mentalizing. Observing familiar goal-directed actions, the autistic children confirm an impairment of their mirror neuron system and a dysfunction in their relation with objects.

The results of those studies and some others provided useful information about the way in which the matching between perception and action is achieved. In normal condition, the anatomical identity of the body parts moved by the model and the spatial locations of the movements in space are integrated and used to perform imitation [101]. Following brain damage, sometimes only the anatomical or the spatial imitation is possible.

The others are referred to a willingness to clarify the debate on the supposed deficit of the imitative function of the autistic children [102-106]. The new formulations of cognisciences bring filter work to explore on the extensive psychological literature on imitation. Increased knowledge of cognitive processes (low and high level) at play during imitation as well as better segmentation of activities should allow removing the contradictions of the old data and thus better analyzing the autistic symptoms [107-109].

The last reasons are motivated by the low knowledge that one possesses of the autistic motor skills and that one could evaluate from the passing of an engine sequence composed of a sequence of actions in different imitative conditions. This test would be informative of the skills and deficits of each autistic child, compared to children with typical development, diagnostic elements directly operational in pedagogy via imitation.

Imitation is considered as a platform for interdisciplinary studies, where social sciences, cognitive psychology, neurobiology and neurocybernetics interact, as well as clinical psychology. Researches use several paradigms to study motor skills and social dimensions in typical children, those with autism spectrum disorder, the mentally deficient or in the aging of standard seniors and pathological. These paradigms analyze the mental health and motor control of these populations, drawing on the contribution of the psychology of interaction between individuals, encompassing the sense of the self and the meaning of the other. Understanding and processing these interrelationships could be a new target for developing the search for cognitive, emotional, relational and social well-being.

Indeed, imitation invested structurally in the interrelationship itself-the other (imitating-imitated). Our field of action would also focus on the psychosociological and neurological basis of this interrelationship concerning the ownership (owning one's body) [110-114], the agentivity (being the author of its actions, the recognition of self and self-respect) [115], the living-body (seat of the reactions of the organism immersed in the environment) or the body-lived (seat of emotional feelings) [116,117]. In fact, the system of agentivity benefits from the contribution of the psychology of interaction between individuals, to recognize its own actions, to be able to attribute others those, which belonged to them. For Clark and Damasio the body must be the origin of the architectures of high level [118-120]. Cognition is embodied when aspects of the agent's body, beyond the brain, play an important role in the cognitive process of the Self/Others bond. Cognition is no longer conceived as a symboloical process of processing information, but as an integration and interaction of a set of information communicating between the brain, the body and the environment.

This integrative approach using would allow us to better understand and define on the one hand, the boundaries between oneself and the other through these different registers, the capabilities of postural and motor control, the coupling of perception-action [4] and, on the other hand, to analyze the behavioral repercussions of these interrelationships [17]. Body and action would be factors of self-building and supports of empathy (putting oneself in the place of the other) [121] and theory of mind (deciphering the thought of the other) [122].

Experimental protocol

The children would be individually invited to reproduce linked successive motor actions in different imitative conditions. The general idea was that an imitative motor production would depend on (i) the spatial and/or temporal imitative conditions linking the demonstration and its reproduction and (ii) the familiarity relationship maintained by the imitating with the imitated action. These differences would correspond to more or less complex treatment modalities in the hierarchy of cognitive processes, which would explain the:

- Differences in scores obtained according to the imitation conditions of such task to a given age or for a given pathology (dissociation of the mental and physical age).
- Differences in scores obtained for the same task according to age or for a given pathology (dissociation of the mental and physical age).

Description of the imitative conditions

The manipulated variables concerns:

1. **Time**: The duration separating the executions of the model and the child one: simultaneous imitation, time-lag imitation, delayed imitation.
2. **Space:** The child and the adult officiated in the same space (two sub-conditions – point of view of observation and execution, identical or different –) in parallel spaces (necessity to translate into the space of evolution what it was seen in another space).
3. **Learning**: The child and the adult would be invited to reproduce the linked successive motor actions in ten consecutive weeks, with each time a week interval, a repeated demonstration of the model and a delay between 5 minutes and 15 minutes between the demonstration and the reproduction.

Description of the linked successive motor actions

During the construction of the linked successive motor actions consisting of a series of sequences, we tried to respect several constraints:

1. Each of the sequences of the linked successive motor actions would (at least in isolation) include simple motor gestures that are part of the current vocabulary of a young three-year-old child who did not discharged from an enriched motor experience: walking-jumping, grasping unmovable balls and carry them to another place, open a container, take the hidden object inside this container, store it after changing its place and introduce it into the holes provided for this purpose.
2. The child's execution of the linked successive motor actions corresponds to the resolution of particular constraints, which we have chosen from several orders:

(i) Spatial constraints: Concerning the reports of the body to local spaces: (example move on and between small obstacles, jump in a hoop, take an object in a symmetrical place).

Concerning the relationships of the body to the space of objects: (example point in a prescribed and precise spatial order on an object).

(ii) Coordination constraints: For example, walk alternating associated to a jump, open with one hand and grasp on the other.

3. The execution of the whole linked successive motor action also corresponded to the resolution of specific evaluable constraints.

(i) Spatial constraints: They concern the localization of the body in the global space (example, moving in the experimentation room in a prescribed direction: egocentric and exocentric spatial frameworks).

(ii) Memory constraints: For example, respect without forgetting or swapping the order of the sequences of the successive motor actions.

(iii)Semantic constraints: For example, schedules arbitrary, and complex motor sequences of actions, implement custom capabilities.

Methods

We would be interested in the selective dimension of what would be really imitated by the child. The variable studied would be therefore the degree of the performance conformity of the autistic child compared to those obtained by children with typical development and mentally deficient children under identical conditions (same motor actions, even the same imitative conditions). The video film would be the technical support of this study; the motor behaviors would be then coded according to the degree of compliance achieved in each of the manipulated variables, for each of the successive motor actions, in their sequence and in each of the imitative conditions.

Apparatus

All children of each population would be tested in the gymnasium of their school. Videotape equipment would be set up for filming and recording the children's responses digital video camera. The following apparatus would be designed to reproduce the demonstrated locomotive and prehensive actions of interest. Locomotive movements would be performed on and between cases. Two boxes (50 cm × 25 cm × 20 cm), each containing an umbrella, would be symmetrically placed on the floor, 20 cm apart. A container (30 cm × 20 cm × 20 cm) with tennis balls would be placed behind each box. Four small cases (30 cm × 20 cm × 10 cm), 25 cm away one from the other would be positioned in front of and behind the boxes, respectively.

Procedure

Each child/adult of every age group of every population would be individually instructed by the model to watch and do exactly the same thing he had just done in two execution directions. At outbound, the children had to:

(1) Walk and jump on the first two cases. Following this, they

(2) Grasped two tennis balls placed in the right-hand side container, carried them and put them inside the second container on the left-hand side. Then, they

(3) Opened the box placed on the right hand-side, picked up an umbrella that was in it, and carried it to the left side. With the umbrella, they pointed to three holes drilled in the box, and afterwards they put the umbrella inside the left box. They ended by

(4) Walking and jumping between the last two cases. At homebound, the children had to reproduce the same linked successive motor actions as at outbound.

Discussion and Imitative Conditions

Each child/adult of each age group of each population would be individually invited to perform in three different imitation conditions over two separate experimental series. The first series was reserved for two successively realized imitation conditions in the same day:

(1) Immediate and simultaneous imitation in two parallel spaces (ISI//S): The adult model and the child were positioned side by side. The adult model asked each child/adult of each age group of each population to observe and perform at the same time and in the same direction, but each in his own spatial course. Each child had one trial. This imitation did not require a recalling mechanism.

(2) Time-lag imitation (TLI): Just after finishing the previous imitation, the adult model invited each child/adult of each age group of each population to reproduce alone the same course without accompanying him/her. Each child/adult had one trial. This imitation would require a short-term memory using an incidental encoding because he/she did not expect a further test.

(3) Deferred imitation (DI): The second series of tests was reserved for the deferred imitation (DI) during ten successive sessions (one session per week). Each child/adult of each age group of every population was individually asked to reproduce alone the course, after each adult model's demonstration at each session without observing others. This imitation would require a long-term memory using an intentional encoding because he/she was warned to reproduce later (Figures 1 and 2).

Coding and Statistical Analysis

From the recording of children's executions, each action sequence of interest was coded separately, both for the generation of goals and their locations into tables in dichotomous data (1-0). The response was scored as 1, if the children matched the model's actions to accomplish the goals and their spatial locations, and as 0, if they did not match the model with regard to the goals and their locations. The statistical process of binary data mobilized specific methods. The dichotomous codes transformed in percentages did not share out according to a normality law, and thus did not allow the normality test. Therefore, in order to be able to apply an adequate ANOVA, it was necessary to use a log-transformation of the performances. The most frequently used transformation was an angular transformation of percentage [123]. The statistical significance level was set at $p < 0.05$.

Two post hoc tests were used to measure the significant effect of variables with more than two levels to determine what this effect should be ascribed to:

(1) The reduced distance test was used to measure the significant interaction effects in the accomplishment of goals.

(2) The comparison test from a proposition to a theoretical proposition test was used to measure the significant interaction effects in the spatial location of goals. The statistical measures taken by the latter test showed that a model's spatial matching was validated if the score was >80%, whereas the score <80% corresponded to a haphazard location. The dependent variable was: the matching responses (%) of goals and their locations. The independent variables were: age group (Six levels: 4- to 8-year-olds), execution direction (two levels: outbound and homebound), and trial (ten levels of repetitions) [123-130].

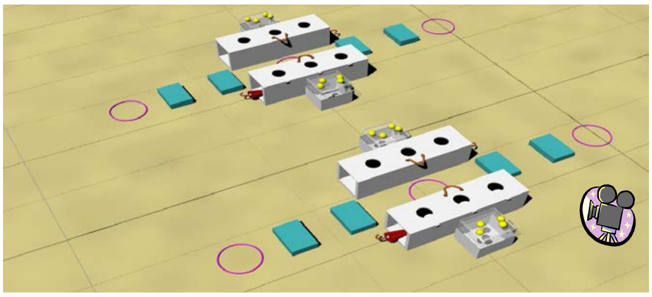

Figure 1: The linked successive motor actions in immediate and simultaneous imitation (ISI//S) and Time-lag imitation (TLI).

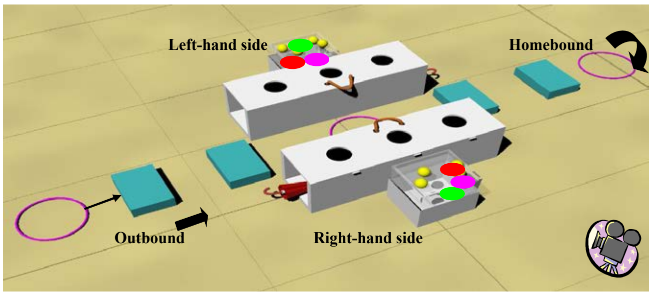

Figure 2: The linked successive motor actions in deferred imitation (DI).

Conclusion

Our goal is to characterize the traits of autistic motor skills in reference to normal and mentally deficient development. We are in the process of developing a scale of difficulties of each and all of the linked successive motor actions, based on scores obtained by 120 children of 6 age groups divided between 3 years and 8 years. This developmental scale completed, should provide a baseline for understanding in what type of constraints the autistic child would be specifically deficient in the management of his imitation. The comparison with mentally deficient children also seems indispensable.

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