

# Motor Function of Autistic Children: What Type of Control?

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## Abstract

Henceforward, autism is considered as a neurodevelopmental disorder characterized by a deficit of language and communication both associated with a restricted repertoire of activities, motor actions and interests. The aim of the current work was to investigate into a comparative study between standard and autistic children the production of successive linked motor actions. We predicted that the autistic children as the standard ones succeeded to perform the basic motor actions like walking, catching, jumping or running. For example, all the children succeeded to throw the scarf (75%), even if the autistic children sometimes interrupted the execution of this task by stereotyped and repetitive movements (23%). A pragmatic control handled their performances. However, we also advanced a deficit of more cognitive levels in performing those motor actions in planning plan because they required a semantic control. For example, to place the circle in the marks drawn in the ground, the autistic children performed this task in (8 s  $\pm$  13.2 s) contrary to the standard ones (0.5 s  $\pm$  1 s).

**Keywords:** Autism; Successive linked motor actions; Motor function; Pragmatic and semantic control.

## Introduction

Given of the plurality and diversity of autistic behavioral, investigations varied according to the periods of study, the evolution of concepts and the technological progress. According to the DSM IV classification, autistic behavioral disorders concerned several deficits essentially affecting the communication competences and the interpersonal and social understanding [1-3]. For many years ago, psychoanalytic approach monopolized a long way the scientific, educative and therapeutic discourses of autism [4-6]. This monopolization was considered as a theoretical hegemony particularly pregnant at the institutional discourse. For twenty years ago, literature data explained the autistic behavior by a dysfunction of central nervous system [7,8]. Thus, some interpretations coming from clinical observations coupled with experimental approaches were established to light the autistic disturbances, like disorder of perceptive threshold, desertion of inter-sensorial modalities, deficit of habituation mechanism, dysfunction of executive functions, motor baldness or metabolic disorders [9-11]. From now, the perception disorders, deficits of minding, deficits of planning and disruptions of executive functions were the most psychophysiological investigations that strongly explaining autism [12,13].

Both, neuropsychological and psychological approaches revealed that autistic child has bad theory of mind and then a difficulty to imitate [7,14]. Therefore, the cognitive neuroscience explained autism by a series of deficits in language, imitation or in emotional functions [7,15-18]. These deteriorate cognitive mechanisms were well known for their important role in the implicit social norms and codes learning [2]. It was particularly noted an affected pragmatic language, qualitative imagination deficiency and an incapability to understand the implicit constraints of relational situations. Additionally, autistic child was judged with actions' restricted repertoire often stereotyped and ritualized with incongruous center of interests. Ozonoff and Mcevoy and Jarrold and Russell recognized the existence of executive dysfunctions in autistic associated with difficulties in planning capability [11,12], shortcomings of organization and incapability to change the strategies or to muster the information in a coherent all because of a weakness of central cohesion [7].

All the dysfunctions seemed exert some deficits on autistic motor

function [7,19,20]. There was an inventory of motor strangeness classically presented in literature. For example, Rutter, Ornitz evoked the disorders of muscular tonus, postural adjustment, disorders of ambulatory explaining the small steeps in walking and parasite of motor actions as the stereotypy [21,22]. Prior described vestibular and laterality disorders and a deficit of sequentialization's process of gestures order [23]. Beaune et al. revealed a relationship between the motor stereotypes of autistic child and a highly selection of visual exploration [24]. Edelman in his model "theory of selection of neural groups" renewed the means to think the cerebral functions and consecutively, the relationships between cognition (reasoning, language and mind representation), perception and action [25]. This author suggested a stimulate hypothesis in the functioning of the nervous system vis-à-vis to the normal and pathologic returns of subject to his human and physical environment. He explained that the architecture and duration of neural transient regroupings would vary according to the task, its execution constraints and subject's experience.

Somewhere else, and with a complementary way, Edelman suggested setting the tasks into two subcategories. In one category, the treatment exacted to carrying out a symbolic and reflexive relationship order generated in the present and future [26]. In the second category, there was only a simple causality control well known and mastered by the subject. The two categories were referred to two distinguished integration levels. In this logic, Edelman interpreted the mental complaint with serious disturbances of mechanism(s) providing the working of the global categories. The deficit will be more reverberated on the tasks complaining the more important integrative level. If we suggest an extension of Edelman's conceptions in the motor control domain, basing on the neurophysiological models of actions, it would be

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possible to explore the executive hypothesis of autistic motor function. A principal differentiation of two great and gradual levels; semantic versus pragmatic control [26,27] or sensorimotor versus cognitive treatment [28-31], was formulated. Rossetti [31] gave a complex neurologic building to this treatment and control. Consequently, the capability to unite, assemble, link or regroup actions, objects, events would be disturbed in the autistic.

This autistic incapability to construct a coherent all postulated by Frith seemed find concordances with the biological data [32]. O'Loughlin and Thagard introduced the weakness notion in the central coherence of strength in autistic persons controlling the information's at an analytic level to detriment of the global analysis [13,33]. There was an important suggestion that peripheric coherence was associated to the central coherence for a strong cognitive reasoning. The peripheric coherence permitted the control of environmental information and the central coherence permitted the control and analysis of the information's at a global level [34].

Planche et al. specified the treatment mode of information in the autistic to research if he or she privileged a sequential or simultaneous information treatment. Those authors found that the simultaneous treatment appeared very weak because when some items needed to be memorized (more than 4 items) or a strategy of regrouping needed to be organized, the fails were flagrant and glaring [35].

At a behavioral level, the thematic around a default of holistic function in autistic child was widely studied in perceptive, cognitive and relational domains, but it was few investigated in the motor function register. Basing on the neurophysiological data, we suggested that the semantic control of the sequential organization of actions involving a second order of treatment requiring a social stake would be short and deteriorate in autistic. Inversely, the pragmatic control of motor execution of those actions would be preserved. For this reason, we suggested in the present work the production of successive linked motor actions to study the autistic motor function. This would be determinant for the treatment modalities hierarchy complex providing pertinent explanations for the adopted management strategy both by standard and autistic children. Many raisons justified the choice of this study:

Motor production process is typically a subject of study explored by several scientific fields and disciplines in which the cogniscience domain started to investigate the motor function of autistic child. An increasing acknowledges of cognitive process involved during the motor production and a better segmentation of activities braced the oppositions of the early psychoanalytic data and so better analyzing the autistic disorders. Weak acknowledge of autism motor control motivated us to purpose this type of study and investigated into successive linked motor actions. This work would be informative of the abilities and deficits of autistic motor function.

## Methods

### Participants

Forty-eight children divided into three groups were asked to individually perform successive linked motor actions. To study the motor function over a developmental scale, sixteen 5-year old's and sixteen 6-year-olds children composed the first and the second standard groups respectively (8 males and 8 females in each group: M=5.5-year-olds, range=between 5 and 6-years of age). The third experimental group was composed of sixteen 10-year-olds autistic children (12 males and 4 females, ranged between 8 and 10 years of age) with equivalent mental age as the standard ones. The parents of the all participants gave

a written informed consent. The study was conducted with the approval of the local ethics committee of the Paris Descartes University in accordance with ethical standards of the latest Declaration of Helsinki (64<sup>th</sup> WMA General Assembly, Fortaleza, Brazil, October 2013).

### Procedure

Both standard and experimental children groups performed the successive linked motor actions following an adult instruction. Then, each child of each group performed the same task every week during eight sessions in random order.

### Task

Every child of every group had individually to: (1) jump on a materialized obstacle (bench). Following this, he or she (2) thrown a scarf into a circle to 2.5 m of distance. Then, he or she (3) jumped into a circle and (4) passing the circle through all the body and then adjusting it on marks drawn on the ground. He or she ended by (5) coming back to the departure point and jumping on the bench.

The choice of the motor actions was argued by their existence both in the standard and autistic children repertoire and did not require any learning. Certain actions provided to verify the pragmatic control. Other actions determined the mean with which the cognitive dimensions were involved in the motor executions. For example, passing the circle through all the body and its adjustment on marks drawn on the ground was a typical situation for exploring the semantic control (Figure 1).

### Apparatus, coding and statistical analysis

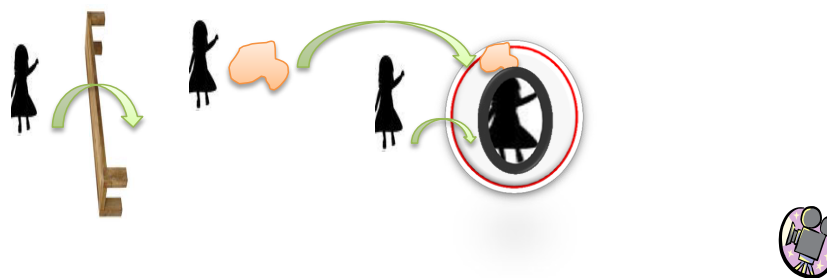
The children were tested in the gymnasium of their school. Videotape equipment was set up for filming and recording the children's responses using a JVC SR-VS10 VHS/DV digital video camera. Their performances were then seized with SAIS NAC 2 software, providing to record action event by a distinguished code and the moment in which was reproduced the successive linked motor actions (Table 1). The total and inter-events durations (second) were then measured for each children group. The inter-groups comparisons were statistically treated with variance analysis ANOVA and completed with a post hoc test NewMan-keuls, carried out for measuring the significant effect of variables with more than two levels to determine what this effect should be ascribed to. The statistical significance level was set at  $p < 0.05$ .

### Depended variables

- Execution order of the successive and linked motor actions.
- Inter-events durations.
- Total events durations.
- Annexes gestures and their durations.
- The previous variables represented the semantic control of action, its planning and understanding of its social stake. They were globally the indicators of successive and linked motor actions learning.
- Durations of events.
- The success and check in throws
- The previous variables represented the pragmatic action control.

### Independent variables

- Three groups of children: two standard groups and an experimental one.
- Eight sessions.



**Figure 1:** Passing the circle through all the body and its adjustment on marks drawn on the ground was a typical situation for exploring the semantic control.

Sequences	Motor sequences	Codes	Durations	Observations
Jumping1	End of impulse left leg	E	-	-
	End of impulse right leg	R	-	-
	End of impulsion joint feet	T	-	-
	Beginning of landing left leg	Y	-	-
	Beginning of landing right leg	U	-	-
Scarf throw	Beginning of landing joint feet	I	-	-
	Low rocking left arm	1	-	-
	Low rocking right arm	2	-	-
	Upper rocking left arm	3	-	-
	Upper rocking right arm	4	-	-
	Low rocking joint arms	5	-	-
	Uper rocking joint arms	6	-	-
	Arriving of scarf in circle	Z	-	-
Jumping2	Arriving of scarf in circle	ç	-	-
	End of impulse left leg	O	-	-
	End of impulse right leg	P	-	-
	End of impulsion joint feet	Q	-	-
	Beginning of landing left leg	S	-	-
	Beginning of landing right leg	D	-	-
Scarf strategy	Beginning of landing joint feet	7	-	-
	Beginning inclining or attitude change or direction to the scarf	G	-	-
Cecle strategy	Reach of scarf	\$	-	-
	Began of inclining	H	-	-
	Reach of circle	J	-	-
Rectification	Put of circle	K	-	-
	Beginning of inlining or change of direction	L	-	-
Jumping3	Release of cricle	M	-	-
	End of impulse left leg	W	-	-
	End of impulse right leg	X	-	-
	End of impulsion joint feet	C	-	-
	Beginning of landing left leg	V	-	-
	Beginning of landing right leg	B	-	-
	Beginning of landing joint feet	N	-	-
	Dustbin code	é	-	-

**Table 1:** Performances were then seized with SAIS NAC 2 software, providing to record action event by a distinguished code and the moment in which was reproduced the successive linked motor actions.

## Results

According to our main working hypotheses, the results of the current work were organized into two distinguished and gradual registers. The first one concerned the pragmatic control of the motor actions and the second register concerned their semantic control.

### Pragmatic control

The statistical results showed that the basic actions' scores concerning the throw of scarf, the inclination of body for catching or jumping were comparable and stable over the sessions in the three children groups: F

(3,21)=5.28,  $p>0.05$ . For example, all the children succeeded to throw the scarf (75%), even if the autistic children sometimes interrupted the execution of this task by performing stereotyped, repetitive and annexed movements (23%). The temporal duration of these actions as the first jump was comparable (5-year-olds:  $0.27 \pm 0.36$  s; 6-year-olds:  $0.31 \pm 0.44$  s; autistic children:  $0.31 \pm 0.12$  s respectively).

The statistical results also showed a strong stability between the three jumps in the two standard children groups. There was a Tendency (no significant) for an extension of the jumps durations in autistic children:  $F(3,21)=2.261$ ,  $p>0.06$ . Their first and second durations jump was statistically similar also justifying a temporal jumps stability.

There was no significant difference between the three children groups both in inclining to catch the circle and in its passing through all the body:  $F(3,21)=4.067$ ,  $p>0.05$ . The reaching duration over the sessions was also stable however; the duration in passing of the circle was variable. There was a significant difference between the children groups/sessions during the passing of the circle through all the body. This Newman-Keuls revealed that the difference was indebted to the autistic ones. They included during this action annexed and parasite gestures.

### Semantic control

The statistical analyses showed that during the execution of linking successive motor actions, the autistic children were significantly different to the standard ones:  $F(3,21)=10.51$ ,  $p<0.03$ . They were globally slower to product the second action comparatively to the standard children (1 to 5-6 s). There was a great variability of this duration in autistic children opposed to a stability in standard ones. This signified that the standard children consecutively linked the throwing of scarf to the second jump with a stable delay independently to the sessions, while the autistic ones attempted to recuperate the scarf following a fractioned temporal delay. The inter-events temporal durations of the autistic children did not decrease over the sessions contrary to the two standard children who progressively decreased these durations. For example, the temporal duration separating the body inclination for catching a scarf and the second jump, the standard children took less time (5-year-olds:  $0.86 \text{ s} \pm 1.01 \text{ s}$  and 6-year-old:  $0.61 \text{ s} \pm 0.88 \text{ s}$  respectively) than the autistic children ( $5.70 \text{ s} \pm 9.4 \text{ s}$ ). In the temporal duration separating the body inclination for catching the circle and the second jump, the standard children also took less time (5-year-olds:  $2.33 \text{ s} \pm 2.01 \text{ s}$  and 6-year-olds:  $1.98 \text{ s} \pm 2.05 \text{ s}$  respectively) than the autistic children ( $2.67 \text{ s} \pm 4.86 \text{ s}$ ).

The standard children respected the order of actions' succession contrary to the autistic ones. They showed frequent inversions in the execution order attesting a default of organization in their planning of actions.

The total temporal duration of all successive linked motor actions was exceedingly variable in the autistic children, while the same duration decreased in the two standard children. This variability was fundamentally due to the obsessional behaviors, which were scratched on the required movement. For example, to place the circle in the marks drawn in the ground, the autistic children performed this task in ( $8 \text{ s} \pm 13.2 \text{ s}$ ) contrary to the standard children ( $0.5 \text{ s} \pm 1 \text{ s}$ ).

### Discussion

The main aim of the present work was to explore the autistic control motor. According to Jeannerod [26], the motor control would rest in the cooperation of two semantic and pragmatic controls. Rossetti [31] specified that the semantic control complained a wide intervening of the integrators' processes, while the pragmatic analysis would be considered by a restricted intervening. This justifies both the deficit of the autistic children motor function in the semantic control and the preservation of their pragmatic one. In fact, the pragmatic control allows children to essentially perform the actions [27]. The second higher level is activated to focus linking and relationship of actions associated to the semantic control [27,36,37]. The quantitative and qualitative results widely confirmed our hypothesis. On one hand, the motor productions, whence the major vocation was the resolution of the physical spatial adjustments that were entirely comparable to the standard children motor productions. The autistic children thrown, jumped and caught with equal execution stability than the standard children. On the other hand, a very clear differentiation appeared since when semantic

dimensions were introduced in the control motor of actions [33]. The temporal durations calculated between the events seemed be a pertinent parameter to explain the progressive construction of the coherent all [7]. The statistical treatments concerning the temporal inter-events durations, the total duration of the successive linked motor actions, the observations of the obsessional behaviors, the scheduling default perfectly confirmed our expectations. The autistic children performed their gestures during durations with a successful comparable degree to the standard children. However, they were significantly different in their capabilities to chunk and link the gestures into a coherent all. The behavioral results were in accordance with the Frith's hypothesis concerning the incapability of the autistic children for constructing a coherent all.

The standard children demonstrated that they understood the social stake of the motor situations, performing rapidly the basic successive linked motor actions. The autistic children did not seem understand this finality. The statistical analysis revealed that the temporal evolution over the sessions was not comparable to this one of the standard children. In fact, after performing two to three sessions, the standard children stabilized their temporal durations until eighth session. However, the autistic's variability was important attesting that usually their goal's action was derived with a temporal lengthening until the fourth session.

### Conclusion

Autism is a neurodevelopmental disorder characterized by a deficit of language and communication both associated with a restricted repertoire of activities and interests. Kanner et al. and Schimtz et al. noted that the autistic children revealed anomalies at the motor function level. However, they were able to practise physical activities [7,20,21,38-41]. They were performant into more simple and basic motor production, as walking, jumping, throwing, running with the same way as the standard children. The difference between the two populations was observed when the semantic dimensions were introduced in the control of the motor function [41].

According to Ciccone et al. [42], autistic patients would be activated to participate more fully in their health care motor. This shift would allow them to use the «partnership» with their doctor and care manager to gradually build the motivation to make behavior changes that could impact their health. As autistic patients made changes in their behaviors, increasing physical activity, increasing self-monitoring behaviors, and becoming more adherent to testing and treatment recommendations, their clinical indicators also change in a positive way. Overall, these changes have the potential of reducing isolation, increasing communication and emergency care costs as well as leading to greater satisfaction among patients, doctors, and care managers.

Despite these original results reported in the current study, it could present some limitations. The sample size was small to examine the parameters related to the two pragmatic and semantic motor control. This weakness would negatively impact our work hypotheses. For this reason, the same subject is actually investigated by a Master2' student, increasing the number of the autistic children (forty-five participants). Because increasing the sample size would strongly determine the shortage of the autistic motor abilities, thier complex cognitive and semantic treatment and the absence of social using of objects, events and situations.

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