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DEVELOPMENT OF SELF-RECOGNITION IN TODDLERS: A MICRO-GENETIC ANALYSIS[1]

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Abstract

Several authors have stressed complexity of factors implied in Mirror Self-Recognition (MSR) and differences in data collected in different researches. In particular, the relevance of rouge-task procedure in establishing child self-awareness is questioned because of the large range of onset age. We can investigate some of the still unsolved problems in the rouge-task procedure, namely intra-individual and inter-individual differences in age of performing the task using micro-genetic design.

We observed 28 toddlers aged between 14 and 29 months, twice a week, in a day-care centre. Observations ended after three consecutive success in the tasks. We find a great inter-individual variability: the age at the onset of performance varies from about 17 months to 27 months. Intra-individual variability is very high as well: some infants resolve the task abruptly, and his/her performance remains stable, others have a period of unstable performance before the onset of competence. The age trend of success suggests a quite rapid change after the middle of the second year. From a methodological point of view, we find no influence of task repetition, and no influence of different administration conditions. These results can help in understanding the rouge-task characteristics and the developmental trend of responses.

Self-awareness
Mirror Self-recognition
Rouge task
Toddler
Micro-genetic design

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DEVELOPMENT OF SELF-RECOGNITION IN TODDLERS: A MICRO-GENETIC ANALYSIS

INTRODUCTION

Mirror Self-Recognition (MSR) is a typical index of self-awareness, utilized by researchers since Preyer (1882) seminal observations. Some decades ago, a reliable index of self-recognition, independent from language or communicative development, was proposed by Gallup (1970, 1994) with chimpanzees, and by Amsterdam (1972) with infants: the *rouge task* (or *mark* or *spot task*).

The task consists in surreptitiously marking an invisible part of the toddler's face and then observing the infant's response to his/her mirror image: if the child touches his/her face or tries to wipe off the mark from the face, (s)he succeeds in the task and is supposed to display self-recognition.

The rouge task became the standard tool to evaluate self-recognition and self-consciousness in animals and infants. Several studies in different domains adopted this experimental procedure (see Courage, Edison & Howe, 2004; Molina, 2004; Vyt, 2001, for reviews).

However, results and their interpretations in terms of self-awareness are not always simple or straightforward (for a recent discussion, see Bard, Todd, Bernier, Love & Leavens, 2006). Particularly, the age of performing the task is quite different in different researches (cf. Molina 2004).

In Table 1 we present the results concerning MSR of 28 different researches, from 1972 (Amsterdam) to 2008 (Lewis & Carmody)[2]: the developmental trend is clear, as the range of response shows: until 15 months very few children recognize themselves, while at 24 months, almost all the children show self-recognition. Between 15 and 24 months, the results are not so clear: different researches show very different percentages of success.

Table 1: Age of recognition in 28 different researches

Age	Percentage of success
12-14 months	0-18%
15-17 months	0-50%
18-19 months	15-90%
20-21 months	42-93%
22-24 months	62-100%
More than 24 months	82-100%

Then, the percentage of "self-aware" children widely changes from study to study: we wonder whether

- these results are due to the experimental conditions, that can differ from each other in minimal aspects;
- individual differences in the onset of self-recognition may play a role: samples are generally small, and individual differences may be relevant in producing differences among results of different researches;

[2] A meta-analysis is in progress

- acquisition of self-recognition may present a period of instability, influencing the infant performance, particularly in laboratory settings.

In our research we tried to analyse the task using a micro-genetic design, to better understand the process of recognition and the conditions influencing the task's performance. We tried to respond to the following questions:

1. Which is the range of individual differences?
2. Is MSR a stable or instable acquisition?
3. Do experience and contextual suggestions play a role in facilitating self-recognition?
4. What is the overall trend of response by age?

METHOD

The micro-genetic design

We used a micro-genetic design to intensively study the period of onset of self-recognition. The micro-genetic method (Siegler, 2004) covers the period of major change on task, with height of density of observations relative to the rate of change of the phenomenon and it allows an intensive (qualitative and quantitative) analysis of data, aimed at revealing the underlying representations and processes that gave rise to the observed changes.

Sample and procedure

We observed 28 infants (17 girls, 2 couples of twins, *** firstborn) aged between 15 and 26 months at the beginning of our observations, and between 16 and 29 months at the end. Almost all the infants was full term born (22 of 28 children) and came from intact families (25 of 26 families). Mothers' mean age was 37 (range 23-48 years), fathers' mean age was 38 (range 29-47 years). The majority of parents were born in the local area (8 of 25 fathers and 14 of 26 mothers), but 6 fathers and 7 mother were strangers. The majority of the sample were middle-high or high Socio-Economic Status (SES) families.

We performed our observations in a day care centre of the city of Turin (Italy), observing all the infants whose families accepted the enrollment in the research, on the basis of infants' age. We observed infants twice a week (about 9 observations each month), for a variable period depending on the time necessary for the MSR. The overall observations number amounts to 243 (means age 21 months, range 15-29, SD 4 months), the mean of observations per infant is 16 (range 3-37, missing included). Observation conditions (spot colour or position, type of spot – spot or sticker – and type of application, room of observation, etc.) varied not systematically, depending of practical constraints on the task conditions, and we controlled differences afterwards.

Six observers performed the observations, but each infant was observed by a single observer. We videotaped all the observations, then, each observer coded the data from the videotape and made a *paper and pencil* protocol of each test. A second observer (Marotta) coded all the observations from the videotape, and a third observer (Molina) coded a sample of 117 observations, including all the disagreements from the coders. All the disagreements were resolved by discussion.

Data analysis

We controlled the inter-rater agreement (by Cohen's K); the influence of contextual conditions and gender using Mann-Whitney Exact Test.

We performed a descriptive analysis of infants' responses, and defined the same qualitative clusters of response.

Finally, we analysed the total amount of observations (243), to detect the rate of change in MRS and find a function interpolating observed data. For this analysis we considered infants performing consecutively three time the task as mastering MSR, then we attributed the success also to responses between last observation and final observation date or age (the end of July, when the day care closed for summer holidays, or 29 months, the age of our last observation): these "virtual" observation were 222, then the total amount of considered observations was 465.

Results

The inter-rater agreement was Cohen's Kappa = .84 for the first control (dichotomous variable, agreement for 168 of 180 cases) and Cohen's Kappa = .81 for the second (dichotomous variable, agreement for 106 of 117 cases).

Infants' responses are shown in Table 2, showing also qualitative response clusters.

Ten children already recognized themselves when our observation started; 7 of them succeeded in the task since the first observation (*Experts*), while 3 did this after one or two trials (*Late experts*[3]). In these groups we can't detect the exact age of first recognition, because it came before the first observation (23-27 months, average 24 months, for E*xperts*; and 21-25 months, average 23 months, for *Late experts*).

Recognizers are five children that recognized themselves after some or numerous failed trials. The range of the age of first recognition varies between 18 and 27 months (average: 23 months).

Six children sometimes succeeded in the task, sometimes failed (*Instable*). At the first observation, they are 15-19 months-old; when they recognized themselves first, they were 15-21 months-old (average: 18 months).

Finally, 7 children never succeeded in the task (*Non-recognizers*). Among them, the older one was 28 month-old at the last observation (*range* 16-28 months, average: 22 months).

These results show a great amount of inter-individual differences: the onset of MSR range from 18 months (15 months if we consider instable performances) to 27 months, and some infant did not reach the success in the task even at the end of our observations (i.e. 28 months).

[3] We supposed that the delay in MSR was due to the strangeness of experimental situation

Table 2 : Infant's performance on the *Rouge Task*

	Subject	Obs. Period	1st Recognition	Sex	Obs.1	Obs.10	Obs.19	Obs.28	Obs.37
Experts	NI18	27-27	?	F	+ + +				
	NI06	23-24	?	M	+ + + +				
	NI04	25-25	?	M	+ + + / ? ? ? ?				
	NI05	25-27	?	F	+ + + + + +	+ + + +			
	NI01	24-25	?	F	+ + + +				
	NI09	24-24	?	F	+ + +				
	NI07	23-23	?	F	+ + +				
Late-Expert	NI03	25-26	?	F	- - + + +				
	NI11	23-24	?	F	- + + + + / ? ? ? ? ?	? ? ? ? ? ?			
	NI13	21-23	?	F	- + + + + +	+ + + + + + + + +			
Recognisers	NI08	26-28	27	M	- - - -	+ + + + +	+ + + +		
	NI02	26-28	26	M	- - - +	- + +	+ + + +		
	NI10	24-26	24	M	- - - - +	+ + + +			
	NI17	18-20	20	F	- - - - - -	- - - - - + + / ?	+		
	NI24	17-18	18	F	- - - - - +	+ +			
Non recognisers	NI12	24-28	/	M	- - - - - - - -	- - - - - - - -	? / - - - - ? ? / - -	-	
	NI15	19-22	/	F	- - - -	- -	- - - -		
	NI20	17-18	/	F	- - -				
	NI21	16-19	/	F	- - - -	- - - -	- - - -		
	NI25	16-16	/	M	- - -				
	NI26	15-17	/	M	- - / ?	- -			
	NI30	15-16	/	M	- - - - - -	-			
Instables	NI14	19-23	21 ?	F	- - - - - - / ?	- - - - - ? - - - - - - - / ?	- - - + - - / ?	- - - - / ?	- -
	NI16	18-22	18 ?	M	+ - - + + / ?	- - - - - + +	- + - - -	-	
	NI19	17-19	17?	F	+ + + + - - + / ?	- + / ?			
	NI22	15-18	16?	F	- + + / ?	- ? ? / + +	? ? + +		
	NI23	15-18	16 ?	F	- - - + - - / ?	- - - - / ?	+		
	NI27	15-16	15 ?	F	+ - - -	- -			

Intra-individual differences were present as well, but not for all children: children showing instable performance ranged between 15 and 23 months.

We did not test directly the learning effect resulting from task repetition. Nevertheless, our data indirectly support the idea that learning is not sufficient to perform the task: we observed some children in the same conditions for months before they succeeded in the task (and some of them did not succeed at all, even in the third year).

We cannot detect systematic contextual influences on infant's performance as well: moreover, in our research setting, environmental prompts were more probable when infants failed the task! Only some errors in the procedure, producing children's awareness of spot application, seemed to increase the probability of success.

We detected no differences regarding methodological differences: spot colour (bleu, grey, violet or yellow), type of application (with hand or using towels), spot position (cheek, forehead or hair), room utilized for the observation, didn't produce differences in children's responses.

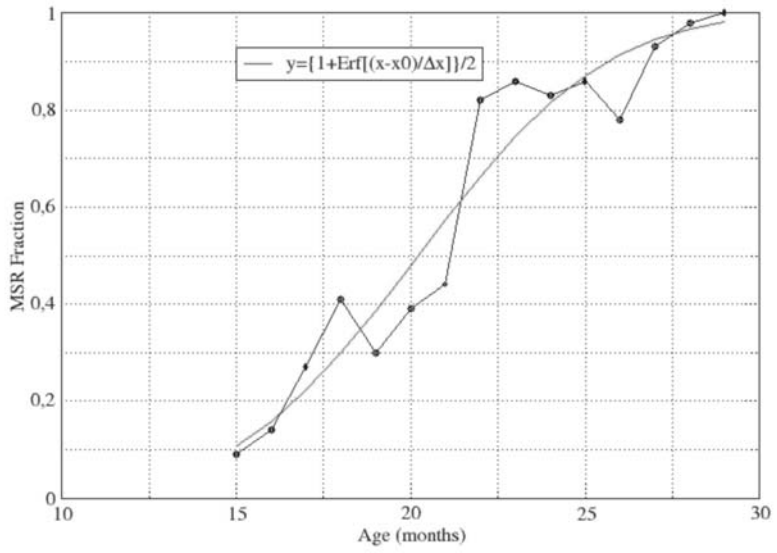
The sticker utilization seemed to reduce the probability of success, but we used the sticker only when children were not able to succeed in the spot task, therefore a more systematic analysis of sticker effect is necessary.

We found a significant difference between male and female in overall data (Mann-Whitney Exact Test, Monte Carlo Method: U = 6132,00, P = .02), but differences in number and distribution of boys and girls by age suggest to be cautious in interpreting these differences.

Figure 1 shows analysis of overall data, in order to detect the rate of change. It has been assumed that the percentage of success raises with an S-shaped curve, in a non-linear way. The equation proposed, starting from the means by months, is an *Error function*, depending on 2 parameters estimated from the data: the $\mathbf{t_c}$ (time central), the age at which the probability of success reaches 50% (20.22 months) and the Delta (= 5.96), indicating the characteristic transition time in months.

Therefore, at about 20 months, the probability of success is 50%, at 14 months the probability is practically 0, whereas at about 26 months is close to 100%.

Figure 1 : MSR Fraction by months



Computed values:
a0 = 20.22
a1 = 5.96

Chi-square: 0.105297
Correlation coefficient: 0.963265
RMS per cent error: 0.176897

DISCUSSION AND FURTHER RESEARCH DIRECTIONS

First of all, the most evident result in our analysis is the presence of marked inter-individual differences in acquisition of self recognition: observed age of success range between 15 and over 28 months (estimated: 14-26 months), a very large period considering that we observed infants and toddlers. Intra-individual differences are also present, but not in all children: instable responses seem more probable in the middle of the second year, i.e. between 15 and 23 months. These results can perhaps explicate differences found in experimental research, mainly because samples are generally quite small.

From our observations we can suggest that learning effects do not play a relevant role: we observed some children in the same conditions for months before they succeeded in the task (and some of them did not succeed at all).

Contextual prompts also didn't influence child performance: we cannot detect any differences in success linked to controlled conditions.

Nevertheless, some infants need one or two trials before they can perform the task. These infants seem to be more cautious in the task situation, probably due to temperamental aspects influencing in a general way the performance: this is a relevant aspect, perhaps neglected in laboratory settings.

Finally, the observations suggest the possibility of fitting data to an S-shaped non-linear function, centred at an age of about 20 months, and covering a transition period of about 12 months.

Further research directions may cover gender differences (our data seem to suggest some gender difference, but this aspect need further investigation), and developmental aspects influencing individual differences in infants' performance.

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