Introduction

Several studies have provided strong evidence of influence between socioeconomic status (SES) and language acquisition, but no study has explored the possible connection between failure of development of spontaneous imitation of actions and poor language abilities.

Numerous studies1–5 have reported how socioeconomic disparities profoundly affect physical health, mental well-being and cognitive development. Hackman et al.7 discovered that the most intellectual abilities influenced by SES are the linguistic areas of the left hemisphere and the prefrontal cortex in the frontal brain.

No differences were found for total cerebral volume or parietal and temporal lobes in children by SES. Disadvantaged children tend to experience less linguistic, social and cognitive stimulation from their caregivers and home environments compared to children from higher SES homes8,10.

Imitation plays a central role in the development of motor control, speech/language/communication, and social life.11 Imitation is one of the most common ways for children to acquire motor or speech/language skills.

Children use imitation to learn new motor skills and communicative actions and to facilitate comprehension of other individuals’ behavior.12 Neurophysiological studies discovered mirror neurons in macaque monkey and similar system
of “mirror neurons” in humans. It is plausible that the mirror neuron system may be involved in imitation in typically developing individuals and also provide the neurological basis for imitation deficit in the specific language disorder. The location of these neurons in the equivalent of Broca’s area, suggested that shared meaning form the basis of communicative movements, gesture and speech, that all originate from the firing of these mirror neurons supporting a close relationship between movement and language. Based on his work on imitation Marshall and Meltzoff have developed the “like me” hypothesis of infant development: there is an intrinsic connection in the infant mind between observed acts and similar executed acts. Infants project their own internal experiences onto others performing similar acts. As a result, infants begin to acquire an understanding of other minds and their mental states (desires, language, visual perception and basic emotions, for instance). This hypothesis suggests imitation is inborn, and the understanding of other’s mental states is a consequence. Later research has included the investigation of memory, communications development, and intention. In collaboration with Decety, Meltzoff has started to investigate the neural mechanisms underpinning imitation, empathy and gaze-following. Other research has shown that gestures help the child in constructing the meanings of words. Child used functions: pointing, with conventional gestures such as “yes”, “no”, “good”, “hello”, which imitate gestures of specific representation of objects, actions or events.

The goal of the present study is to explore how SES may affect develop of language and the possible connection between failure to develop spontaneous imitation of actions and poor language abilities in a random sample of normal children.

**MATERIALS AND METHODS**

Two indicative measures of SES are used in this study: index of multiple deprivation (IMD) and maternal education status. IMD is a composite measure of deprivation and it is based on information from seven domains (income, employment, health and disability, education, skills and training, housing and service, crime and living environment). Maternal education is clearly a reflection of human capital (not material influences), while IMD measures of income and employment reflect financial capital (basic needs as food and clothes). Information on years of maternal education and IMD scores was collected by means of parental surveys (questionnaires). The maternal education factor is divided into three groups: statutory minimum numbers of years leaving full-time education (high school), further education, higher education to degree level. Social capital is reflected in IMD measures of housing and services, crime and living environment.

Our study focused on 60 children (30 males, 30 females) aged from 3 years to 5 years and 11 months (mean age 4 years and 6 months) with apparently normal language development. No child had certified diagnosis of the disorder. Information was collected by administering specific surveys during the 2014-2016 school year in a public nursery school of a poor area in Bari and in a private nursery school of Noicattaro. The tool used for the linguistic analysis was the NRDSL test (Italian version), administered by clinicians to all 60 children.

The IMD factor is divided into two groups: one presents the NRDSL test scores obtained from children in a public nursery school of Bari, the other group presents the children’s scores on the test selected in private school of the residential district of Noicattaro. Children attend a public school located in the Libertà neighborhood in downtown Bari. This neighborhood is a multicultural environment subjected to urban pollution with few gardens and with a high crime rate. Every child had 10 toys, lived in a family with a middle-income <15.000 euros income tax 2014, played with family members for less than two days a week and did not practice extracurricular activities. Instead, children in the other group lived in Noicattaro, a residential district with large green areas and gardens to play in, with little pollution and with a lower crime rate. Every child had more than 10 toys on average, lived in a household with a higher income >20.000 euros income tax 2014 played with family members for more than two days a week and practiced extracurricular activities.

The tool used for the linguistic analysis was the NRDSL test. It was administered in Italian language to all 60 children by clinicians. The NRDSL test contains 72 items for comprehensions, divided into seven sections, 64 items for productions divided into seven sections. It is administered using objects, toy animals and picture books. Sections in both scales cover early vocabulary nouns and verbs, relating two objects, simple sentences, grammatical inflections and complex sentences. The comprehension scale also has sections on pronouns and inferencing and the production scale includes a section testing grammaticality judgement.

Three sections of NRDSL test are used to study imitation with 28 items. The NRDSL imitation test scores and spontaneous observation scores were added to get a total score. The NRDSL imitation items are 21 and the spontaneous observation items are 7: total items 28. The maximum score is 56, two points for each item (Table 1).

**Data analysis**

All demographic and clinical variables were subjected to statistical analysis. Descriptive analysis was conducted for socio-demographics featuring two samples. To compare age and gender between the verbal and nonverbal groups, we used respectively the Mann-Whitney U test and the chi-square test. In addition, the chi-square test was used to determine whether there was any difference between the expected and observed values in various categories (Mother’s study title, Income, Toys, Family playing time, Sport, and School type) between verbal and nonverbal groups. The Mann-Whitney U test is a nonparametric test and it was used to examine the difference of the NRDSL (Production, Understanding, and Imitation scales) scores between verbal vs nonverbal groups and public vs private school. A P-value of less than 0.05 was considered as statistically significant. For statistical processing, we used the Statistical Package for Social Science version 20.0.

**RESULTS**

We studied 60 children (30 males and 30 females) aged from 3 to 5 years and 11 months. The NRDSL Italian version was administered in a public nursery school of Bari and in a private nursery school of the Noicattaro residential district. The mean of the children’s age in the public school was 4 years and 6 months versus 4 years and 7 months in the private school. The analysis of comprehension, production and imitation are not different between children in public and private schools (Table 2).
Table 1. Imitation Test.

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>imitation present</td>
</tr>
<tr>
<td>1</td>
<td>partial imitation</td>
</tr>
<tr>
<td>2</td>
<td>imitation absent</td>
</tr>
<tr>
<td>Max</td>
<td>score: 56</td>
</tr>
</tbody>
</table>

Section: Relationship between objects 1

- **Materials**: teddy bear, rabbit, bed, apple, spoon, box.
- **Instructions**: manipulate objects while saying the sentence. Explain that the child will have to repeat what the operator says. The operator says:

  Are you able to say what I say?
  1) The teddy bear is in the box. Now you tell me.
  2) Here are the rabbit and the bed. Now you tell me.
  3) The spoon is in the box.
  4) Here are the teddy bear and rabbit.
  5) The rabbit is in the box.
  6) Here are the apple and the bed.
  7) The spoon is on the bed.

**Spontaneous observation**

  1) In section Relationship between objects, does the child manipulate the objects according to the operator’s instructions in items?
  2) Does the child after each item look at the operator?
  3) Does the child try to imitate the words and repeat the sounds?
  4) Does the child repeat the actions of the operator?

Section: Relationship between objects 2

- **Materials**: teddy bear, truck, box.
- **Instructions**: remove the previous objects. Sit next to the baby. The purpose is to get the baby to tell where the teddy bear to see his movements and to analyze his movements. The operator places the teddy bear and says:

  Where’s the teddy bear?
  NB: Truck orientation is important: make sure the front of the truck is facing the child and the operator in each item.

- **Score**: punctuate as appropriate if the child performs the action of the operator even if the appropriate prepossession/adverb (eg on, in, below) is not used with an appropriate name (eg truck, car, wagon) or a Pronoun (eg this one). Carefully analyze the gestures and actions of the child.

  1) The operator places the teddy bear in the box. What does the baby do?
  2) The operator places the teddy bear under the box.
  3) The operator puts the teddy bear over the truck.
  4) … near the truck. Near/next to / next to the truck (car, wagon, this)
  5) … under the truck. Under the truck (car, wagon, this)
  6) … in front of the truck. In front of the truck (car, wagon, this)
  7) … behind the truck. Behind the truck (car, wagon, this)

**Spontaneous observation**

  1) In this section, does the child manipulate the truck according to the operator’s instructions in the various items without speaking?
  2) Does the child repeat the actions of the operator?
  3) Does the baby look after the item concerned after each item?
  3) Does the child try to imitate the words and repeat the sounds?

Section: verbs

- **Materials**: monkey
- **Instructions**: use the monkey to perform each action. The goal is to stimulate the production of the verb and to analyze the gestures of the child. Each form of the verb is acceptable (eg jumping, jumping, jumping, jumping). The operator takes action at the monkey and says:

  What is the monkey doing?
  1) The operator skips the monkey. What does the baby do?
  2) The operator does the monkey run the baby. What does he/she do?
  3) The operator salutes the monkey. What does he/she do?
  4) … applauding. What does he/she do?
  5) … walk. What does he/she do?
  6) … sit down. What does he/she do?
  7) … fall.

The child fails to produce the corresponding verb but tries to take the monkey from the operator or perform the action himself?

Total score:
In the NDLS test, 19 children had scores below -1DS and are not verbal. 41 children are in a verbal group.

Comparing the NDLS scores between the verbal and nonverbal group (Table 3) we found statistically significant differences in Production scale (p<.0001), Understanding scale (p<.0001), and Imitation scale (p<.0001). Children in the nonverbal group reported more problems in Production, Understanding, and Imitation scales compared with children in the verbal group (Table 4).

In addition, we found only differences in more mothers with degree in verbal group compared with non-verbal group (p= .023). The mothers of children in the verbal group were characterized by a high degree of academic level, on the contrary mothers of children in nonverbal group are characterized by compulsory education or high school diploma (Table 5).

**DISCUSSION**

Our study found no effects of SES on language acquisition, but the mother’s degree is probably important in language development. Edward et al.24 equally saw an increase of NDLS scores associated with an increase in years of maternal education. Rowe25 and Sylva et al.26 analyzed a number of features of child’s communication and have found also more social skills were present in wealth families and by the frequency of pre-schools.

Roulstone et al.27 have identified environmental factors that act as mediators in the first learning of language, such as the number of books available for children, the frequency of libraries visited, the teachings of parents and the number of toys available for children. These authors have shown that these factors are more strongly associated with the first language learning compared to broader measures of socio-economic status.

Letts and Edward’s sentences, found within the group of children with uneducated mothers, a number of children with

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**Table 2. Descriptive sample analysis.**

<table>
<thead>
<tr>
<th></th>
<th>Public School Group (30)</th>
<th>Public School Group (30)</th>
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<tbody>
<tr>
<td></td>
<td>mean</td>
<td>Sd</td>
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<tr>
<td>Comprehension</td>
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</tr>
<tr>
<td>Production</td>
<td>39.82</td>
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**Table 3. Descriptive sample analysis.**

<table>
<thead>
<tr>
<th></th>
<th>Tot (N=60)</th>
<th>Verbal (n=41)</th>
<th>Non-verbal (n=19)</th>
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<tr>
<td></td>
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<td>Mother’s study title</td>
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<td>Degree</td>
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<tr>
<td>Income</td>
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<td>ns</td>
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<td></td>
<td>&gt;15000</td>
<td>19</td>
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<td>22</td>
<td>9</td>
<td>ns</td>
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<tr>
<td></td>
<td>&gt;2gg</td>
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<td>10</td>
<td></td>
</tr>
<tr>
<td>Sport</td>
<td>YES</td>
<td>22</td>
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<tr>
<td></td>
<td>NO</td>
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<tr>
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<tr>
<td></td>
<td>Private</td>
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<td>10</td>
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**Table 4. Statistically significant differences in production, understanding and imitation scales between verbal and non-verbal subjects.**

<table>
<thead>
<tr>
<th></th>
<th>Verbal (n=41)</th>
<th>Non-verbal (n=19)</th>
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<tr>
<td>Production scale</td>
<td>Mean</td>
<td>SD</td>
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<tr>
<td>Production</td>
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<td>Imitation scale</td>
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<td>.743</td>
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**Table 5. Statistically significant differences in mother’s study title between verbal and non-verbal subjects.**

<table>
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<th></th>
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<th>Count</th>
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<tr>
<td>TOT</td>
<td>41</td>
<td>41</td>
<td>19</td>
<td>19</td>
<td></td>
</tr>
</tbody>
</table>

(*) Fisher exact test
a score of -1DS (according to the categories defined by Wiig et al.26 higher in children aged 5 years and 6 months).
In our study, we found association between imitation capacities and verbal skill. Numerous studies have analyzed the imitation in autism spectrum disorders, but few studies have studied imitation in specific language impairment. Charman et al.27 demonstrated that imitation of action or objects at the age of 20 months was associated with language ability in the fourth year of life. De Giacomo et al.30 have highlighted that a reduced or totally absent spontaneous imitation of action in children with autism disorder is related to reduced or totally absent communication skills. In children with SLI, imitation skill and gestural joint attention have been found to correlate with verbally responsive abilities. Children with SLI performed more poorly than their peers in body posture imitation, and their performances indicated more complex errors than those observed in typically developing children. Sentence imitation has been identified as a good indicator of children’s language skills, with performance differentiating children with specific language impairment and showing relationships with other language measures.

Our study showed that children with impaired imitation show in NRDL very limited expressive language. Although, imitation and verbal communication are independent for socioeconomic status. This association, in fact, could be explained by the fact that during the pre-linguistic stage of child development, communication is based on nonverbal behavior such as gaze, facial expression and body language to communicate their needs, wishes, and social intentions and gesture often conveys information that is not conveyed in the speaker’s words31,32. Furthermore, during the first stages of verbal skill development, language always accompanies the child’s play and only after age two do children abandon their own gestures in favor of the exclusive use of verbal language, when they can manage it in a more mature way. Our findings seem to support the concept that failure to develop imitation skills could affect the whole communication domain, both gesture and verbal, in language disorders80.

Several authors discussing modern neuropsychological interpretations have assumed that mirror neurons act as a bridge between perceived action and language. It is important to note that a human mirror neuron is involved in imitation and probably in language31-35.

The present findings support the new concept of a neuropsychological implication of the mirror neuron system in these language deficits. Also Volkterra et al.28 showed that gestures help the child in construction meanings of words, imitation gestures help language development.

CONCLUSIONS

The correlation between imitation and communication skills can be useful for planning rehabilitation treatment for these children. Watchful waiting alongside well informed classroom teachers coupled with appropriate classroom language enhancing activities could be successfully implemented for the other children to ascertain whether these children are slow developers who will catch up or have atypical development and require specialist intervention. The present study is limited by the population sample than is necessary additional support from previous finding.

Acknowledgements: we would like to thank dott. Pietro Iafaldano for his valuable collaboration in statistical process.

Conflict of interests: the authors have no conflict of interests to declare.

REFERENCES
21. Legambiente dossier Urban Ecosystem, October 26, 2015 to 6th place on Bari 100; values Pollutant: O2 = 42; NO2 = 12; SO2 = 1.5; CO = 185; PM10 = 10; PM2.5 = 5.3; Legambiente October 26, 2015.
22. Il Sole 24 Ore September 2014; April 6, 2014 Bari is at 33rd place out of 106 cities under consideration.