Phonological and Semantic Verbal Fluency Tasks in a Sample of Argentinean Children

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Abstract

The aim of this work is to obtain data about the evolutionary pattern of performance in verbal fluency tasks for a sample of Argentinean primary school aged children (3rd, 5th y 7th grade) in semantic and phonological verbal fluency tasks. For the semantic fluency task, children were assessed in different categories: animals, fruits and vegetables, and body parts for living things domain, and means of transport, musical instruments and clothes for inanimate objects. For the phonological fluency assessment, children were tested with /f/, /a/ and /s/ phonemes. Both fluency tasks showed differences between grades, indicating the influence of education. Besides, irrespective of the grade, children performed better on the semantic fluency tasks. Results in the semantic fluency task also showed a better performance for the living things domain over the inanimate objects domain. Further analysis on the results showed that 3rd grade children have the worst performance, compared to 5th and 7th grade children. The results of our work are discussed taking in account cognitive mechanisms, executive functions and semantic memory development.

Keywords: Semantic fluency, phonological fluency, educational status, children.

Fluência Semântica e Fonológica em uma Amostra de Crianças Argentinas

Resumo

No presente trabalho oferecemos dados de tarefas de fluência verbal para crianças argentinas de 3°, 5° e 7 ° ano do ensino fundamental. Os participantes foram avaliados com uma tarefa de fluência semântica, que testou as categorias de animais, frutas e legumes e partes do corpo para o domínio dos seres vivos e meios de transporte, instrumentos musicais e roupas para os objetos inanimados. As crianças também foram avaliadas com uma tarefa de fluência fonológica que testou os fonemas /f/, /a/ e /s/. Os dados obtidos apontam para diferenças de desempenho entre as tarefas e mostraram um melhor desempenho

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nas de fluência semântica. Além disso, nas tarefas de fluência semântica os participantes tiveram um melhor desempenho no domínio dos seres vivos. Tanto para fluência semântica quanto fonológica, as diferenças estiveram presentes quando os grupos foram comparados pelo nível de escolaridade, de modo que os alunos de 3° ano se dissociam significativamente dos 5° e 7 ° anos, produzindo menor quantidade de exemplares. Os resultados são discutidos à luz de possíveis diferenças originadas no desenvolvimento cognitivo, as funções executivas e o sistema semântico.

Palavras-chave: Fluência semântica, fluência fonológica, nível de escolaridade, crianças.

Fluidez Verbal Semántica y Fonológica
en una Muestra de Niños de Argentina

Resumen

El objetivo del presente trabajo es obtener información del patrón evolutivo de desempeño en tareas de fluidez verbal para una muestra de niños argentinos de nivel primario de 3°, 5° y 7° grado. Se evaluó a los participantes con una tarea de fluidez semántica, en la que se evaluaron las categorías de animales, frutas y verduras, y partes del cuerpo para el dominio de seres vivos, y medios de transporte, instrumentos musicales y ropa para el de objetos inanimados. Asimismo fueron evaluados con una tarea de fluidez fonológica en la que se testearon los fonemas /f/, /a/ y /s/. Los datos obtenidos dan cuenta de diferencias de rendimiento entre las tareas de fluidez con un mejor desempeño en las tareas de fluidez semántica. Asimismo, en las tareas de fluidez semántica se observa un mejor rendimiento en el dominio de seres vivos. Las diferencias obtenidas en ambas tareas se identifican al comparar los grupos según escolaridad, siendo únicamente los niños de 3° grado los que, con menor cantidad de ejemplares recuperados, se disocian significativamente de los de 5° y 7° grado. Estos hallazgos son discutidos a la luz de posibles diferencias en función del desarrollo cognitivo, de las funciones ejecutivas y del sistema semántico.

Palabras claves: Fluidez semántica, fluidez fonológica, escolaridad, niños.

Verbal fluency measurements are frequently used in neuropsychological research and clinical practice, as they are easy and quick to administrate, but also because of the high degree of reliability their results have for diverse pathologies (Fernández, Marino, & Alderete, 2004; Henry & Crawford, 2004; Henry, Crawford, & Phillips, 2004). In a verbal fluency test, participants are asked to provide as many examples as possible for one or several categories in a certain amount of time, for example, in one minute (Lezak, Howieson, & Loring, 2004). There are two variants of the verbal fluency tests: semantic verbal fluency (SVF) and phonological verbal fluency (PVF). In the first, the participants must look for as many examples as possible of a specific semantic category (for example, *animals or fruits*). In the PVF, the participants are asked to indicate as many words as possible that begin with a certain sound (for example, /p/ or /s/).

In verbal fluency tasks, diverse cognitive mechanisms are brought into play for the task: working memory, sustained attention, executive functions, semantic memory, search and recovery strategies for lexical items, among others. Because of this, verbal fluencies are very sensitive measurements when it comes to evaluating cognitive plasticity and organization strategies (Henry & Crawford, 2004; Lezak et al., 2004; Stuss et al., 1998). Even though both tasks require executive demands (Hirshorn & Thompson-Schill, 2006), word recovery in the SVF is based on semantic associations and the meaning of each one of them, while the PVF implies strategies that are not typically used and which require more effort (Hurks et al., 2006).

Both SVF and PVF are useful tools to diagnose certain neurological pathologies. SVF results are highly sensitive for research into degenerative diseases (Lezak et al., 2004). The

scores in this type of task are used to diagnose early onset Alzheimer's and are an important predictor of Parkinson's Disease and other types of dementia like vascular dementia, the semantic variant of Frontotemporal Dementia or subcortical dementia; likewise, they are useful to identify patients with Huntington's Disease or ones with psychiatric conditions like schizophrenia (Binetti et al., 1995; Chertkow & Bub, 1990; Galaverna, Marino, & Abraham, 2008; Hodges & Patterson, 1997; Rosser & Hodges, 1994). Patients will specifically fail when they have problems maintaining attention; this is caused by difficulties in the frontal lobe or when they cannot recover examples due to alterations in the temporal lobe. Patients with focal frontal lesions have difficulties in the PVF, as they cannot properly use the cognitive mechanisms needed to make the searches, start the responses and perform the monitoring. Patients with temporal difficulties will have problems with the SVF, as they cannot choose or suitably group the examples of different categories evaluated due to difficulties in the semantic memory (Troyer, Moscovitch, Winocur, Alexander, & Stuss, 1998).

Diverse studies have shown that some demographic and social variables have an impact on test performance, with age and the educational level reached by subjects being the two most important variables (Kempler, Teng, Dick, Taussig, & Davis, 1998). Some studies have shown that the results in verbal fluency tests proportionally improve with age (Casals-Coll et al., 2013; Fernández et al., 2004; Kempler et al., 1998; Lezak et al., 2004; Lozano Gutiérrez & Ostrosky-Solís, 2006; Ollari & Diez, 2005; Pekkala et al., 2009). However, there are studies with elderly people that demonstrate the existence of an inflection point (from the sixth decade onwards), where the performance begins to decrease as the age rises. It has even been shown that performance falls more in men than in women (Rodríguez-Aranda & Martinussen, 2006). Educational status is especially important for the PVF tests (Ratcliff et al., 1998). Another socio-demography variable to bear in mind is gender. The studies that are available

show contradictory results. In some cases, gender represented a significant variable in the distribution of the results (Capitani, Laiacona, & Barbarotto, 1999; Laws, 1999, 2004; Marino & Alderete, 2010; Marra, Ferraccioli, & Gainotti, 2007; McKenna & Parry, 1994; Soriano et al., 2015) while, in others, it had no impact or this was only relative (Casals-Coll et al., 2013; Fernández et al., 2004). In general, women have a better performance than men in verbal fluency tasks (Halpern, 1992). In regards to semantic fluency, there are differences but, overall, women are better at the fruit/vegetable and furniture categories and men with animals and tools (Albanese, Capitani, Barbarotto, & Laiacona, 2000).

There has been little verbal fluency task research performed with native Spanish speakers if we compare them, for example, to those done in English (Tombaugh, Kozak, & Rees, 1999). There have been studies done on the Mexican (Ostrosky-Solís & Ardila, 1991), Colombian (Ramírez, Ostrosky-Solís, Fernández, & Ardila-Ardila, 2005) and Spanish populations (Buriel, Gramunt, Bohm, Rodes, & Pena-Casanova, 2004; Villodre et al., 2006). For Argentina, there are some specific studies (Comesaña & García Coni, 2013; Fernández et al., 2004; Marino & Alderete, 2010; Villodre et al., 2006; Zanin, Ledezma, Galarsi, & De Bortoli, 2010).

The verbal fluency tasks, both SVF and PVF, have also been applied to child populations. The results of tests on children have been used in studies on attention deficit disorder, Turner's syndrome, development dyslexia, among others. The PVF test is especially sensitive for detecting children that have Attention Deficit Hyperactivity Disorder (Hurks et al., 2004).

There are several studies about child populations in fluency tasks, most of them performed on Spanish children (Nieto, Galtier, Barroso, & Espinosa, 2008), but it is also possible to find some research done in Argentina (Arán-Filippetti, 2011; García Coni & Vivas, 2014; Marino & Díaz-Fajreldines, 2011). Most interest in child verbal fluency studies comes from the fact that these tasks evaluate cognitive mechanisms that are still being developed, giving a clearer per-

spective about the ontogenesis of these mecha-
nisms. In this sense, sociodemographic variables
are extremely important since they shed light
on the development periods of specific cogni-
tive abilities. In research with children, it has
been seen that age is without a doubt the most
relevant variable. Verbal fluency increases in in-
fancy and during adolescence (Matute, Rosselli,
Ardila, & Morales, 2004). SVF increases mainly
in children between 8 and 11 (Lozano Gutiérrez
& Ostrosky-Solís, 2006) and seems to be related
with a progressive development of semantics in
language. In the same way, the increase in PVF
tasks is lower than in the SVF tasks (Koren, Kof-
man, & Berger, 2005).

Nevertheless, it is still not possible to
indicate at what moment children's performance
in these tests reaches adults´. Some research
projects report that children at age 10 reach a
similar performance to that of adults (Anderson,
Northam, Hendy, & Wrenall, 2001), while
others indicate that this occurs in adolescence or
early adulthood (Klenberg, Korkman, & Lahti-
Nuuttila, 2001). Some research dissociates the
performance of children in SVF and PVF. The
performance of children in PVF would reach adult
levels later than in SVF, where similar levels to
those of adults would be reached between 14 and
15 (Matute et al., 2004). Other studies made on
infant populations have positively correlated the
performance of the subjects, even at school age,
with the educational level reached by the parents
(Ardila, Rosselli, Matute, & Guajardo, 2005).

Until nowadays there is still no accurate
data about the performance pattern of school-age
children in verbal fluency tasks, this work aims
to get to know the evolutionary performance pat-
tern in PVF and SVF of primary education-aged
Spanish-speaking children in Argentina. For the
SVF, data was obtained from several semantic
categories (animals, fruit and vegetables, parts
of the body, clothing, musical instruments and
transports) to obtain a more accurate measure-
ment of the semantic progression of language.
In regards to PVF, data was obtained on the pho-
nemes, F, A and S, as these fluencies constitute
a research tool that is universally used in clinical
assessment.

Methodology

Participants

A sample of 86 children participated in
the research. 32 children from 3rd grade (40.6%
boys) with a mean age of 8.58 ($SD = .38$), 25
students from 5th grade (40% boys) with a mean
age of 10.70 ($SD = .41$); and 29 from 7th grade
(44.8% boys) with a mean age of 12.54 ($SD =
.43$). All the participants were native Spanish
speakers and had no sensorial deficit, neurologi-
cal alterations or learning difficulties that had
been diagnosed at the time of the evaluation. All
the children assessed attended a private school
with an average socioeconomic level from the
city of Buenos Aires. The parent's educational
and occupational level was taken into account to
establish the participant's socioeconomic level.
According to Sautú (1991), at least one of the
parents must have reached tertiary or university
level education to be included in this socioeco-
nomic group. This criterion was considered for
the selection of the sample. The participants vol-
untarily answered the test and they had not only
the authorization of their parents and guardians,
but also from the General Education Planning
Direction of the Government of the City of Bue-
nos Aires for the evaluation.

Procedure

The students from each grade were indi-
vidually assessed with a PVF task and a SVF
task in a single session by one of the researchers
during September 2014. The assessment was
performed during classroom hours in a classroom
provided by the institution for this purpose.

Both tests were taken together, with the par-
ticipants first answering the PVF task and then,
the SVF one.

The assignment for the first task was as fol-
lows: "Please state, in one minute, all the words
that come to your mind, that begin with the fol-
lowing phoneme, with no proper names, for
example M". The participants answered for the
phonemes, F, A and S. Before the evaluation,
it was checked whether the children had under-
stood the assignment and two test phonemes, P

and M, were proposed. Once we were sure that they could do the task, the evaluation began. Once the PVF evaluation had ended, the SVF evaluation was done with the following assignment: "Now, I am going to ask you to tell me, in one minute, all the words that come to your mind about the different categories I am going to tell you, for example, professions". The children answered on categories about living things domain (LT; animals, fruit/vegetables and body parts) and inanimate objects domain (IO; clothing, musical instruments and transports). Once again, two test categories were used as examples (professions and sports) to be clear that they had understood the task. The responses for both tasks were recorded on a digital recording device.

A person then had the role of transcribing the responses of the children, word by word. However, only the names of examples of the categories were considered as valid responses for semantic fluencies. Words that indicate the same exemplar (for example, lion – lioness) were eliminated; superordinate categories were not accepted (for example, fishes). Variations of the same response were grouped into one (for example, green apples, red apples were grouped as apples). Errors from a specific category were removed (for example, dog from the category musical instruments). For phonological fluency, proper nouns or family names were not counted

(bitch, hound, puppy, etc.). Repetitions were eliminated both in SVF and PVF.

Statistical Analysis

In order to identify possible performance differences in the semantics and phonological fluency tasks of Spanish speaking school-age children in Argentina, a mixed variance analysis was done using a 2x3 ANOVA, taking (phonological and semantic) fluency as intrasubject variables and the grades (3rd, 5th and 7th) as intersubject variable.

A second analysis was done to identify possible differences in the processing of LT and IO semantic domains. For this, another 2x3 mixed variance ANOVA analysis was applied. The domain (LT vs. IO) was taken as intrasubject variable and the grade (3rd, 5th and 7th) as intersubject variable. The size of the effect for both analysis types was calculated from the partial Eta squared (η^2).

Results

The performance of the different grades in the phonological and semantic fluency tasks is shown in Table 1, below. The scores presented in this table show the mean average of the examples given by the participants for each semantic category evaluated in the semantic fluency task and for each phoneme evaluated in the phonological fluency task.

Table 1
Mean and Standard Deviation for the Average of Phonological and Semantic Fluency in Each One of the Grades

| Grade | Fluency | | | |
| | Semantics | | Phonology | |
	M	SD	M	SD
3rd Grade	11.17	1.99	4.77	1.72
5th Grade	13.06	2.46	7.32	2.42
7th Grade	13.69	2.29	7.92	2.05

The average amount of examples given for the semantic fluency categories (corresponding to the fluency of animals, fruits and vegetables,

body parts, transports, musical instruments and clothing) was calculated for each participant, as well as the average number of examples given

for each phonological fluency phoneme (corresponding to the fluency of /f/, /a/ and /s/). The first analysis reveals statistically significant differences in the performance in fluency tasks in favour of the semantic fluency, $F_{(1,83)} = 502.30$; $MSE = 3.02$; $p < .001$; $\eta2 = .86$. It also indicates significant differences by grade, $F_{(2,83)} = 22.00$; $MSE = 6.19$; $p < .001$; $\eta2 = .35$. The post-hoc analysis, using the Bonferroni method, indicates that the students from 7th grade do not significantly differ from those of 5th, but both grades differ significantly from those of 3rd ($p < .001$). In the same way, the analysis did not detect interaction effects, $F_{(2,83)} = 0.68$; $MSE = 3.02$; $p = .51$; $\eta2 = .02$.

Table 2
Means and Standard Deviations in the Field of LT and IO in Each One of the Grades Assessed

Grade	Semantic domain			
	LT		IO	
	M	*SD*	*M*	*SD*
3rd grade	13.17	2.37	9.17	2.02
5th grade	15.76	3.32	10.36	2.30
7th grade	16.80	3.32	10.59	1.97

The results of the second analysis are presented in Table 2, and show the performance for the different domains in the different grades in semantic fluency tasks. The average amount of examples produced for each area was calculated for each participant. The LT domain comprises the categories of animals, fruit and vegetables along with body parts, while the IO domain comprises transports, clothing and musical instruments. This analysis shows a significant effect for the semantic domain, $F_{(1.83)} = 341.228$; $MSE = 3.381$; $p < .001$; $\eta2 = .804$. The children produce a greater amount of examples for LT than for IO. There are also statistically significant differences by grade, $F_{(2.83)} = 10.584$; $MSE = 9.992$; $p < .001$; $\eta2 = .203$. The amount of examples recovered increases for students from higher grades. The post-hoc analysis (Bonferroni method) allows seeing that 3rd grade children significantly differ from those of 5th grade ($p < .01$) and 7th grade ($p < .001$), while there is no great difference in performance between 5th and 7th. On the other hand, the domain and grade interaction is also significant, $F_{(2.83)} = 5.693$; $MSE = 3.381$; $p < .01$; $\eta2 = .121$. Just like in the analysis by grade, the students from 3rd grade are only dissociated from 5th ($p<.05$) and 7th ($p <.05$) in the amount of examples recovered for the LT domain, while students from 5th and 7th grades do not produce differences in the amount of examples recovered for this domain.

Discussion

The aim of this work was to obtain information about the performance of Argentinean school-age children in verbal fluency tasks. With this goal, data was obtained for SVF (animals, fruit/vegetables, body parts, means of transports, musical instruments and clothing) and for PVF (FAS test)

Just as in previous studies, the data obtained from the Argentinean population shows that school-age children improve their performance as they get older and attain a better performance in SVF than in PVF (Brocki & Bohlin, 2004; García et al., 2012; García Coni & Vivas, 2014; Matute et al., 2004; Valencia et al., 2000). In this sample, an increase in the amount of correct answers is seen, for both tasks, from 3rd to 5th grade. From 5th grade onwards, the performance in both tasks is no longer statistically significant.

In regards to the SVF, the average number of answers obtained for the animal category for 5th grade children is equivalent to the one reported for Argentinean adults under 45 years old and with incomplete primary studies (Butman, Allegri, Harris, & Drake, 2000). However, in the PVF, although there are no significant differences between 5th and 7th, an increase in the amount of responses given for the phonemes /a/ and /s/ is seen. Unlike what happens with the children in the SVF, the data is not comparable with what is reported for our adult population (Butman et al., 2000). This may be because, with adults, the phoneme /p/ was evaluated. However, bearing in mind that the performance of the children evaluated in our sample is lower; we consider that the difference found in the performance in both verbal fluencies can be explained by the level of maturity of the cognitive systems involved in each one of the tasks. In the SVF, examples of a single category, provided beforehand by the evaluator (for example, animals), must be recovered. This means that the search is limited to recovering the items belonging to a familiar semantic category for the children. Therefore, in the SVF tasks, the executive function mechanisms, which are still developing in children of this age, do not have the same impact as the PVF tasks where the search the evaluated student must do is not limited to a single category and, as such, they must cover a larger amount of subcategories. To do this, children need to make an inter-category search. In addition, they must apply a search criterion which is not solely semantic, as occurs in the SVF, but also the linguistic organization of the items. Because of this, the PVF task is more difficult for children as they must activate inhibition mechanisms to perform the task and thus avoid the production of semantically incorrect related forms for the task (Arán-Filippetti, 2011). These strategic search mechanisms and inhibition mechanisms, sustained by the frontal lobe, would seem to be automatic both during the cognitive development and also in the formal schooling process of the children. As a result, older children perform better searches than younger ones, which is reflected both in the increase in the amount of items produced and also in the accuracy of the items chosen. That is to say, the students from 7th grade present a lower amount of intrusions, for example, of proper nouns in PVF tasks.

In the framework of infant neuropsychological evaluations, phonological fluency tasks provide reliable means in the detection of attention disorders, as this task requires the person being evaluated to keep a sustained attention for prolonged periods of time while different vocabulary search strategies are implemented. The children who have attention deficit hyperactivity disorder (ADHD) tend to have results that are well below average in these tasks, as the period they keep attention for is greatly reduced (Grodzinsky & Diamond, 1992). Likewise, this task is also important in the evaluation of children with dyslexia, as it is a useful means to diagnose and follow-up on the treatment implemented. (Cohen, Morgan, Vaughn, Riccio, & Hall, 1999; Reiter, Tucha, & Lange, 2005).

Unlike other projects that have been done for our population, which have evaluated children's performance in a single semantic category (specifically animals); in our work we test several categories from the LT domain and others from IO domain to be able to identify semantic differences in the infant processing skills.

Our data shows differences in processing in favour of the LT domain. In line with the results obtained by Valencia et al. (2000), the categories of this domain are natural categories and, therefore, fewer years of schooling may be needed to develop them. The data shows that 3rd grade children differ significantly from 5th and 7th only in the LT domain, but this does not happen between 5th and 7th, which have a similar performance. However, for the IO domain no differences are detected between the three groups, which show a lower performance than in the case of the other semantic domain.

Returning to what we said in the introduction, one of the questions that is still in up in the air is about when, during the development, children reach a similar performance to adults in verbal fluency tasks; our data lets us see that 5th

grade children reach a performance comparable with that of young adults with incomplete primary education in the semantic fluency task for the animals' category (sole category contemplated in adult research). Given that our sample is comprised by three non-consecutive groups, the results do not let us know with certainty when, during childhood development, they reach the same capacity of recovering examples from their semantic store as adults do. Therefore, it will be necessary to broaden the sample and include performance data from 4th grade to establish more accurately the moment of semantic development culmination for the animal category.

In regards to the phonological fluency task, it is worth stating that the children of our study do not reach the same level as that of adult subjects evaluated in other works carried out with our population. Therefore, up to 12 years of age, the cognitive abilities involved in phonological fluency tasks are still being developed. To be able to have a more certain knowledge of the moment in which children and adults even out their performance in phonological fluency tasks, it is necessary to broaden the sample and evaluate older children and adolescents.

The dissociation found in the performance between SVF and PVF is in line with the findings of Hurks et al. (2006) and Matute et al. (2004), which state that phonological and semantic verbal fluency abilities are not jointly developed.

On the other hand, given that we do not have a standardized database for child population of our country, this work is of great relevance. This research forms part of a semantic fluency standardization project of diverse semantic categories in children (pre-school and primary aged children), adolescents (secondary school students) and adults.

This work, however, does have certain limitations. On one hand, the population studied is limited to an average population that attends a private school. As a result of this, the sample must be extended by evaluating students that attend public schools. Likewise, the parents' level of studies in our sample indicates that they belong to the middle class; hence information is

needed from the other socioeconomic classes of our country (upper and lower).

Another limitation, bearing in mind the country's population diversity, is that our sample only represents the region of Buenos Aires and possibly just one part of the Province of Buenos Aires. Students from the rest of the regions of our country (north and south) need to be evaluated to identify possible dissociations in regards to the regions.

In this work, the analysis is focused on identifying possible differences in terms of the amount of examples recovered. As a possible line for future research, a cluster analysis could be done (Troyer et al., 1998) to get to know the semantic organization of each one of the categories evaluated with the fluencies.

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