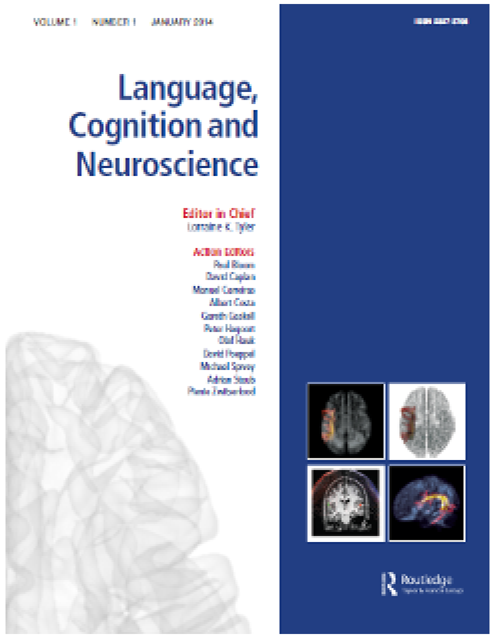

When low self-control is good: children's word learning in an overhearing situation

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Fig 1. Novel objects used in experiment.

70x73mm (72 x 72 DPI)

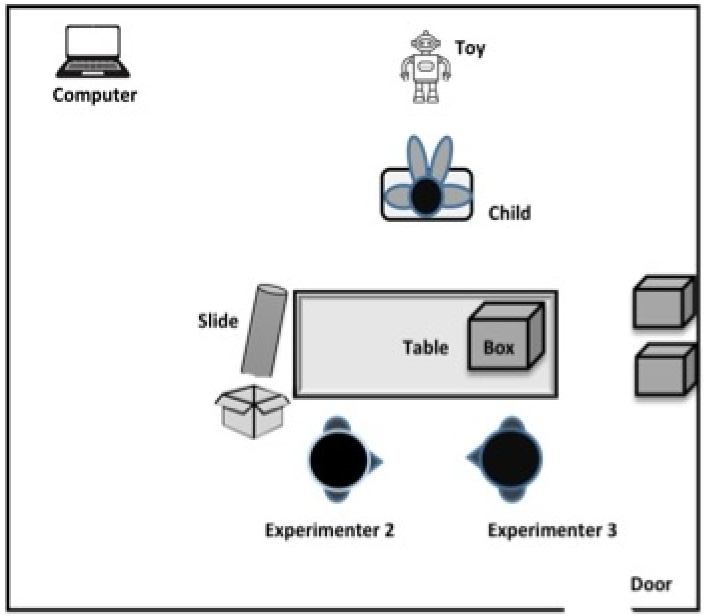

Figure 2. Room layout for the experiment.

123x114mm (72 x 72 DPI)

When low self-control is good: children's word learning in an overhearing situation

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Abstract

Studies of children's temperamental traits show that self-regulation is associated with advanced linguistic development, and that low self-regulation is associated with some deficits in language. We tested the hypothesis that some social settings offer learning opportunities that can be better utilized by children with lower self-control. Thirty-four 3-to-4 year old pre-schoolers from public schools were tested for novel nonword-object mapping. Previous to the test, children were presented to an overhearing setting where novel words were indirectly presented. Results showed better *word-learning* in children who had lower *effortful control*. *Attention focusing*, *inhibitory control* negatively predicted word-learning outcomes, whereas *impulsivity* and *smiling and laughter* were positively associated. These results show that reactivity can result in an advantageous trait for word-learning, while self-regulation may hinder it under specific situations as in an overhearing setting.

Keywords: overhearing, indirect speech, word learning, reactivity, self-regulation, temperament

Introduction

As in Mischel and Shoda's seminal studies, including the famous Stanford Marshmallow Experiment (see Mischel et al., 2011, for a review), advantages and benefits of self-regulation have been broadly studied and acknowledged. The assumption that self-regulation positively predicts developmental outcomes has become what we will call the *standard viewpoint*. In language acquisition, this standard viewpoint can be seen in the facts that children's attentional and self-regulative capacities promote language learning and that, conversely, children's characteristics that interfere with attention and self-regulation, such as impulsivity, inhibit language learning. The present study tests and finds support for an alternative view: that, in certain learning settings, characteristics such as lower self-regulation, or higher levels of reactivity can promote learning.

One of the factors that account for differences in language development that originate in self-regulation is the differences in children's temperament. Temperament comprises the child's natural behavioural dispositions, specifically his *reactivity* and *self-regulation* (Rothbart 1989). Reactivity refers to the child's propensities to become behaviourally or emotionally aroused. Self-regulation refers to the child's capacities to cope with such arousability in order to voluntarily adapt his behaviour to the demands of the situation. Factor analysis (Putnam & Rothbart, 2006; Rothbart, Ahadi, Hershey, & Fisher, 2001) shows that measurements of temperamental characteristics can be organized in three independent factors: *effortful control, extraversion/surgency* and *negative affectivity.* These factors are indicators of self-regulation, motor reactivity, and emotional reactivity, respectively.

Associations between children's language development and indicators of temperamental self-regulation and reactivity have been documented (for a review see

Conture, Kelly, & Walden, 2013). Most of these studies support the standard viewpoint interpreted as better learning being associated to higher self-regulation (measured by the indicator *effortful control*; Rothbart, Ahadi, Hershey & Fisher, 2001), but also, recall that indicators of self-regulation and reactivity are independent from one another, interpreted in terms of poorer learning associated to higher reactivity (measured by the indicators of *extraversion/surgency* and *negative affectivity*). For example, Rieser-Danner (2003) showed that attention span and positive emotionality are associated with more advanced development in cognitive tasks. Dixon and Shore (1997), observed that *duration of attentional orienting*, *smiling and laughter*, and *soothability* positively predict the acquisition of nouns in infants. Dixon Jr and Smith (2000) found that *attentional control* and *positive affectivity* predicted language production and comprehension; while *adaptability* and *soothability*, *mood* and *smiling/laughter*, *attentional persistence* and *duration of orientation* were positively associated with language development. Similarly, Slomkowski, Nelson, Dunn and Plomin (1992) found that *extraversion/surgency* is associated to expressive language at age 3 and receptive abilities at age 7 and Paul and Kellogg (1997) observed that delays in language development are associated to high *shyness* and low *extraversion/surgency.*

The standard viewpoint interpreted in terms of emotional reactivity is supported by findings by Salley and Dixon Jr (2007), who found that low scores in self-regulation and high scores in negative emotionality hinder word acquisition. Similarly, Dixon and Shore (1997) showed that children with higher levels of *negative affectivity* have smaller vocabularies. In a variant pattern, infants and toddlers who spend more time in positive or negative emotional states, show delays in language, relative to children with more neutral states (Bloom, Beckwith, & Capatides, 1988).

To summarize the standard viewpoint in language learning: children categorized as temperamentally *easy-going* (that is, exhibiting higher ratings in *effortful control* and lower ratings in *negative affectivity*) tend to be developmentally advantaged compared to temperamentally difficult children (Salley & Dixon, 2007).

However, some authors call attention to the fact that in complex learning environments temperament acquires adaptive value only when it interacts in a virtuous manner with the environment. Thomas and Chess (1977) introduced the idea of *goodness of fit* to describe how well a child's temperamental characteristics meet the demands of his environment (Thomas & Chess, 1977; Thomas, Chess & Birch, 1968). Rothbart, Ahadi and Hershey (1994) show that temperamental differences result in the same environment being processed differently by different children. The *goodness of fit* between the environment and a child's natural characteristics confers value to such characteristics; which should not be considered as advantageous or disadvantageous *per se*. This is the case even for the child's attentional characteristics: Rothbart and Jones (1998) point out that "attention is not the only route to more positive experiences for vulnerable children. It is important to remember that even the most vulnerable and negative child also has capacities for positive experiences" (Rothbart & Jones, 1998, p.486). This is relevant since institutional learning environments, such as the school, tend to approach the promotion of language development by emphasizing the importance of self-regulation (Al-Hendawi, 2013 for review). This results in institutional settings being organized around self-regulation. However, self-regulation centred learning environments are not always beneficial to all children. Cherkes-Julkowski, Sharp and Stolzenberg (1997) describe how cognitive-behavioural approaches to training self-control tend to fail in children with attentional deficits. All this should draw attention to the importance of investigating alternatives to the standard viewpoint, which is one of the motivations for the present study.

Regarding alternatives to the standard viewpoint, there are studies (Todd & Dixon, 2010; Villarreal, Falcón & Alva-Canto, 2016) that challenge it. Todd and Dixon (2010) found that children with low self-regulation engage more in joint attention, which in turn has been associated to broader vocabulary. Villarreal et al., (2016), found that the indicator of motor reactivity, *extraversion/surgency* (Rothbart, Ahadi, Hershey & Fisher, 2001), was, on the one hand, negatively associated to word learning measured by a preferential looking paradigm, and, on the other hand, positively associated to vocabulary size measured by the MacArthur Bates Child Development Inventory (CDI). Notice that, in principle, these two measurements should be consistent with one another: if a child is a good learner, this good learner should have learned more words. We submit that one possibility to explain this discrepancy, as well as the rest of the counter-standard-viewpoint findings, is that the laboratory task and the developmental index are tapping into different ways in which temperament influences language learning. This is the general hypothesis to be investigated here: that reactivity may influence language learning differently, and even in opposite ways, in laboratory or naturalistic settings.

This apparently counterintuitive hypothesis is possible due to the fact that temperamental characteristics can influence learning through direct or indirect routes (Rieser-Danner, 2003; Dixon Jr and Salley, 2007; and Salley and Dixon Jr, 2007) . Temperament influences language learning, directly, by providing attentional resources or, indirectly, by promoting social interactions. Rieser-Danner (2003), Dixon Jr and Salley (2007) and Salley and Dixon Jr (2007) describe these direct and indirect routes of temperament-language influence: in the *direct route* (e.g., Dixon Jr & Salley, 2007), the child's self-regulative characteristics (which include attentional capacities) influence language learning by providing information processing resources: children with more (attentional resources have more capacity to process information during language learning episodes. In the *indirect route* (e.g., Salley & Dixon Jr, 2007), temperament influences the formation of the social relationships and social responsiveness (Canfield, Saudino & Ganea; Salley, Miller, & Bell, 2013) involved in language acquisition. It is thus possible that in laboratory settings temperamental characteristics may influence learning through a direct route of influence, yielding results consistent with the standard viewpoint. By contrast, in naturalistic settings, a different or even opposite, result may be achieved through an indirect route. Thus, to explain Villarreal et al.'s divergent findings, we suggest that their experimental task may be tapping into a direct route of influence, which yields the standard-viewpoint-expected outcome; whereas the CDI assessment may be tapping into an indirect route, in which temperament interacts with different social settings, yielding a different outcome.

Social settings are diverse and complex, and they have different informational properties. A setting refers to the way in which information is available in a given situation. These informational properties are relevant since they may have an impact on whether a child is in position to take advantage of the information available in the environment. It is possible that there are settings in which language development can be promoted by temperamental characteristics other than self-regulation. We suggest the setting known as *overhearing* as one of those scenarios.

Overhearing

An overhearing setting is a type of social situation in which children witness a speech episode in which they are not direct participants. Akhtar, Tolins, and Fox Tree (2019) suggest that most studies of language learning tend to be biased by the fact that they assume the school-based *teaching-and-testing* model of learning. They thus argue that studying language learning in overhearing settings is relevant to improve our understanding of the natural processes of language acquisition. It has also been found that overhearing promotes language learning differentially, depending on the characteristics of children. For example, Shneidman and collaborators found that children show better learning in overhearing settings depending on children's familiarity with being around adults and familiarity with non-directed speech (Shneidman, Buresh, Shimpi, Knight-Schwarz & Woodward, 2009; Shneidman, Gaskins & Woodward, 2016). Since overhearing scenarios are naturalistic settings whose informational characteristics are very different from laboratory settings, and offer learning opportunities that can be differentially utilized depending on the children's characteristics, they are good candidates to test the idea that reactivity may influence language learning differently in naturalistic or laboratory settings. The informational characteristic of overhearing settings, contrasting with typical laboratory settings, may offer learning opportunities that are better suited to reactive children.

We can now refine our general hypothesis. Children's reactive characteristics may influence language learning differently in complex and diverse settings where information is not explicitly directed to the child. The overhearing setting offers a way to test this hypothesis, as reactive characteristics may put children in position to take better advantage of the informational properties of overhearing settings. More specifically, through an *indirect route* of temperament-language influence, children's reactive characteristics may result in a more active behaviour that allows them to take greater advantage of the learning opportunities in overhearing settings. The reason for this, we further hypothesize, is that a reactive behaviour may result in a more frequent exposure to information in the overheard environment, thus being conducive to better learning.

Learning in an Overhearing Situation

To illustrate how better learning may be associated to reactive characteristics, consider a typical overhearing setting: adults are having a conversation in which some potentially useful information is exchanged. A child is present, but not participating in the conversation. The adults do not address the child. Consider now two children with different reactive tendencies. The first child is capable of self-regulating himself. Many social situations tend to demand self-regulation, from children. This child may devote himself to behaviours that have been shown appropriate in the past. It is likely that, this child would not only stay put, but also would tend to leave adults alone, and would probably not concern himself with their conversations. This behaviour, however, would result in this child missing the information being exchanged in the conversations. For example, he would miss any novel words (and their meanings) used by adults. This child would miss a learning opportunity available in the environment.

Consider now a second child, who exhibits higher reactivity: he has a natural tendency to be aroused by the stimuli around him. In the overhearing situation, he, despite the demands of the situation, would be more likely to be aroused by the stimuli in the environment (i.e. the overheard conversations). In general, this child is likely to show a more active behaviour. A child with an active behaviour may improve his odds of being exposed to useful information, and moreover, not only to information in his immediate surroundings, but also to information in the broader environment. This reactive child is thus more likely to be exposed to novel words, and their meanings, used by adults. In this way, better learning may result from an interaction between the children's reactive characteristics and the informational properties of the environment.

Present study

In sum, by taking into account the existence of direct and indirect routes of temperament-learning influence and the informational properties of the environment where learning takes place, it is reasonable to hypothesize that reactive characteristic may result in better learning in an overhearing situation. Now, unlike previous studies, we do not hypothesize that the mediating mechanism operating in the indirect route of influence is the formation of social relationships. Rather, we merely hypothesize that such mediating mechanism is based on children's exposure to information in the environment. Reactive children may get themselves exposed more frequently to relevant information in the overheard environment, while the self-regulated children may get themselves less frequently exposed.

We must emphasize that, in our hypothesis, children may take advantage of learning opportunities not merely by means of their temperamental characteristics, but rather by a virtuous interaction between such characteristics and the environment. Learning would thus be the result of a *good fit* between the children's reactive characteristics and the environment.

Therefore, in order to ascertain the alternative viewpoint, and to add new supporting evidence for the idea of *goodness of fit,* we test whether low scores in *effortful control*, the main indicator of self-regulation, and high scores in *extraversion/surgency*, the indicator of motor reactivity, is associated to better *word-learning* in an overhearing setting.

Finally, to the best of our knowledge, this is the first study to test the possible advantages of low self-regulation in children. Therefore, our primary interest is to establish the existence of the effect. Since our hypothesis involves an indirect route of influence that means that there is a mediator between children's characteristics and learning. The details regarding the specific mediating mechanism are best addressed once the existence of the effect has been established. Thus, we do not address the details of the mediating mechanism here.

3. Method

Participants

Thirty-four 3-year-old children (24 girls, 10 boys) from two different pre-schools in the urban area nearby Cuernavaca, Morelos in Mexico, participated in the study. Children ranged from 36 to 48 months of age (Mean = 43.11 months, SD = 4.59). Children were Spanish-speaking monolingual and did not show any auditory, visual, perinatal or neurological problems, according to parental report. Children were assessed in public schools in middle-to-low income areas of Cuernavaca. Mothers were 30 years old in average and had completed college (18), high school (4), secondary school (8), primary school (2) and post-graduate education (2).

All children whose parents returned the informed consent and who met the criteria (i.e., age, language and absence of developmental problems) were included in the sample. Five more parents received the questionnaire, however three of them did not returned it and two children were excluded from final data, because of probable autism according to parent's report.

Materials

Sociodemographic Questionnaire. Previously to their child's participation, parents answered a questionnaire regarding children's sociodemographic background. The instrument included questions about perinatal conditions, knowledge or suspicion of any disorder, weight at birth, family members, parent's education and frequency of stimulation activities such as story reading or singing.

Children's Behaviour Questionnaire (CBQ). Parents assessed children's temperamental traits using the CBQ developed by Rothbart, Ahadi, Hershey and Fisher (2001).

In the CBQ, self-regulation and reactivity traits are utilized to define three measurable temperamental dimensions: *Effortful Control* (measuring self-regulation), *Extraversion/surgency* (measuring motor reactivity) and *Negative Affectivity* (measuring emotional reactivity). *Effortful control* is defined as the ability to control a dominant response in order to perform a nondominant one; it involves the voluntary deployment of executive attention and the ability to engage in planning, thus it includes temperamental traits such as *attentional focusing* and *inhibitory control*. *extraversion/surgency* assesses parameters of motor activity and impulsivity. Negative affect refers to emotional reactivity such as fear, anger, sadness, and discomfort.

The CBQ is designed for children between 3 and 7 years of age. Individual differences in 15 temperamental traits, labelled *subdimensions*, are grouped in the three broad dimensions of temperament described above. The questionnaire comprises 195 items inquiring about the parents' observations of their child's everyday behaviour. Parents answer from 1 (never) to 7 (always) according to how accurately the item's statement describes their child.

Spanish edition of the Peabody Picture Vocabulary Test-Third Edition (PPVT-III). This instrument was used to assess receptive vocabulary and to measure general verbal ability. The items in the test are black-and-white drawings. The test contains four training items and 204 test items, grouped in 17 sets of 12 items each. The child sees a page with four different drawings and must select the one that represents the word spoken by the examiner (Dunn, Dunn, & Arribas, 2006).

Behavioural assessment. Four composites of responses were included in the behavioural assessment: *pointing*; which was registered when the child pointed to the experimental objects, *turning head/looking*; which included behaviours such as partially turning the head (from 40º, approximately) or by looking directly towards the experimental objects, *talking;* which was registered when the child started a spontaneous utterance (i.e., asking a question or making any comment*)* and the *distraction* composite; which consisted in behaviours such as touching or taking the robot or turning head or looking to any object out of the experimental scene (i.e., the room's door).

Stimuli

The objects and pseudo-words used as stimuli in the present study have been validated from previous studies and pilots conducted in the laboratory. Novel objects were selected among an original number of 10 objects. The 6 final objects were selected based on a ranking given by ten members of the laboratory on the basis of their novelty and discriminability among them (see Fig 1).

Four of the items served as target objects (T1-T4) and were named with one of four novel pseudo-words: *Melina, Pono, Pada, Bali*. The label used here denotes individual objects, as opposed to denoting categories. This was done to integrate the labels into a coherent history about the "robot's friends" (see Read, Macauley & Furay). The other two novel objects remained unnamed and served as distracters (D1, D2).

Two familiar objects (F1: watermelon, F2: strawberry) were also included in the experiment, the remaining six were novel to all participants.

A toy robot was used to develop the story, and an aluminum tube was used as a prop for the child to throw the objects down the "slide" to help them get home.

/FIG 2 ABOUT HERE/

Design and procedure

Temperament was evaluated with the Childhood Behaviour Questionnaire (CBQ), which was delivered and presented to parents along with a Sociodemographic questionnaire. Parents took both questionnaires home after previous instructions were given and were asked to deliver them back a couple of days after.

The Peabody test was administered to each child individually approximately one week after the word learning experiment.

Word-learning

The *word-learning* experiment was divided in four phases, involving three experimenters (labeled *E1, E2, E3*, from now on) and a participant child. All phases took place in an isolated classroom (experimental setting is shown in Figure 1). There was a table in the middle of the room; the child was seated facing opposite the table and towards E1 (when present). Experimenters 2 and 3 appeared on the other side of the table and at the back of the child; this layout was designed to divide the room into two different spaces; one for the child and one for E2 and E3. The purpose of this division was to physically indicate that the experimenters were not interacting with the child and to foster the overhearing paradigm (see Fig 2).

/FIG 2 ABOUT HERE/

Introduction and Warm-up Phase (E1 and child). During this phase and after a brief rapport, the first experimenter in scene; E1, brings the child to the back of the room, sits him down in a chair and shows him a toy robot that is looking for its lost friends. E1 addresses the child: *You and I need to help the robot find his friends, can you help me?* After the child says yes, E1 says: *Oh no, I forgot to bring my pen, can you wait for me here for a minute?* Then E1 leaves the room.

Training Phase (indirect speech/overhearing paradigm; E2, E3 and the child). In this phase, new experimenters label the target toys with no direct interaction with the child. After E1 leaves the room, two new experimenters, E2 and E3, come into the room and have a conversation. They stand behind the child and never address or have any visual contact with the child. E2 and E3 follow this script:

E2: *Hey, do you know Rodolfo's phone number? It's missing from this list* (E2 is holding a piece of paper, and points to it).

They notice the boxes.

E3: *What is this?* (Indicating Box 1)

E2: *Oh, I know them; those are the robot's friends!*

They take the objects out of Box 1 and label them one by one, in two rounds. Each round consisting of 4 objects, one Distracter, one Familiar object and two Target objects, in the following order: D1, T1 (*Melina*), F1 and T2 (*Pono*), in round 1; and D2, T3 (*Pada*), F2 and T4 (*Bali*), in round 2. Objects as well as labels are counterbalanced across both rounds.

Round 1 (Notice that for Round 2 the same script was followed, but using the remaining objects, D2, T3, F2, T4, and their corresponding labels '*Pada'* and '*Bali'*)

E2 (holding D1): *Wow, have you seen this? This one is very cool, I like this one.* (He hands it to E3, who looks at it).

E3: *This one is cool, you are right, I like it. Let's put this one here.* (He puts D1 on the table).

E2: *Look! It's Melina! Melina is so cool! Melina is amazing!* (Hands T1 to E3).

E3: *Wow! Melina! I like Melina, I'll put Melina here.* (He places T1 on the table).

E2: *Oh, and look! (indicating F1)*

E3: *I'll put it here, too.*

E2: *And this is Pono, have you seen Pono? Pono is also very cool.* (Hands T2 to E3).

E3: *Wow! Pono! Pono is amazing! I'll put Pono over here.*

After naming and placing on the table the four objects, E2 and E3 put them in the boxes (target objects in one box; the distracter and familiar objects in the other box).

E2: *Now we need to put them back in their place. Here, hand Melina to me, I'll put Melina here.*

E3, intentionally making a mistake, grabs F1 instead of T1 and hands it to E2.

E2: *No, I said Melina*

E3 grabs T1 and gives it to E2 who puts it in the box.

E2: *Now, it's Pono's turn. Give Pono to me.*

E3, again making an intentional mistake, grabs D1 instead of T2 and hands it to E2.

E2: *No, not that one! I want Pono!*

E3 grabs T2 (T4) and gives it to E2 who puts it in the box.

Both E2 and E3 put D1 (D2) and F1 (F2) in the other box saying: *And these go here.* After finishing Round 1, the same procedure was repeated for Round 2, with different objects and labels: D2, T3 (Pada) , F2, T4 (Bali). After completing Round 2, both E2 and E3 leaved the room.

Identification and Naming Phase (E1 and child). In this final phase, E1 was in charged of testing the children's learning. Two different linguistic competences were assessed. The first of the two tasks had to do with identification/comprehension (i.e., choosing the right object, according to the name uttered by E1) whilst the second task had to do with naming (i.e., uttering the name of the object selected by E1). In the comprehension tasks, 4 objects (distractor, familiar object, target 1 and target 2) were placed on the table arranged as forming a square. The experimenter asked the child for one of the target objects (e.g., "Can you pick up *pono?"*). Child's response was coded as correct if the child picked up (or clearly pointed to) the corresponding object. On the other hand, in the production task, the experimenter showed the child an object and asked him to name it. This task was performed with the 3 remaining objects (distractor, familiar object and the target). Child's response was coded as correct if she uttered the corresponding nonword.

4. Data analysis

CBQ assessments for the three broad dimensions of *Negative Affectivity*, *Extraversion/surgency* and *Effortful Control* were obtained. These broad dimensions were conformed from the 15 temperamental subdimensions.

Peabody Test

Total raw scores were obtained and transformed to standardized scores, which were used for the analyses.

Table 1 shows the mean, median and standard deviation for the three broad dimensions of temperament and Peabody scores.

Word learning

Word learning was coded as a sum of *identification/comprehension* task + the *naming* task = *total word-learning.* Final analyses were made on the basis of *total word learning* performance.

Behavioural scores

In addition to data associated to the experimental variables, experimenters registered a variety of behaviours exhibited by children during the overhearing phase of the experiment. These scores were registered by E1 while the *training phase* took place. The observer assigned 0 or 1 point when observing one of the behaviours that were part of the composites, independently of the frequency of the observations.

5. Results

Preliminary analyses

Non-parametric correlation coefficients between *word-learning*, *Peabody score,* behavioural observations and all temperamental dimensions are displayed in Table 1.

Correlational analyses between *word-learning* and the three broad temperamental dimensions and each of the 16 specific temperamental traits were conducted. *Effortful control* (*r* = -.37) showed a significant inversed correlation with performance in the *word-learning* task. *Attention focusing* (*r* = -.43), *inhibitory control* (*r* = -.39) and *low intensity pleasure* (*r* = -.31); which are constituents of *effortful control*, also showed a negative correlation with language learning performance. Positive significant correlations with components of *extraversion/surgency* were also observed: between, *impulsivity* (*r* = .31), *smiling/laughter* (*r* = .34) and *word-learning*. No statistically significant correlations between *negative affectivity* (or any of its subdimensions) and *word-learning* were observed.

Peabody scores were negatively predicted by the overall dimension of *extraversion/surgency* (*r* = -.31), *activity level* and *discomfort* (*r* = -.31). *Efforful control or any of the* behavioural scores did not show any significant or marginal relation with performance in the *Peabody test* (p > .1).

For behavioural scores, *pointing* was positively correlated with *word-learning* (*r* = .39) and negatively correlated with *inhibitory control* (*r* = -.33), *positive anticipation* (*r* = -.38) and the broad dimension of *negative affectivity* (*r* = -.40). *Turning head/looking* was negatively correlated with *effortful control* (*r* = -.29), and *low intensity pleasure* (*r* = -.45); and positively correlated with *shyness* (*r* = .41) and *fear* (*r* = .35). *Talking* was positively correlated with *inhibitory control* (*r* = .33), *low intensity pleasure* (*r* = .29), *smiling and laughter* (*r* = .29) and *soothability* (*r* = .44). Additionally, *talking* was negatively correlated with *shyness* (*r* = -.31). *Distraction* score was not significantly correlated with any of the variables.

Table 1. Descriptive statistics and correlations for temperament *dimensions*, subdimensions, *Peabody, word-learning* and *behavioural* scores.

	Mean (SD)	*Word-learning (total)*	*Peabody score*	*Pointing*	*Turning head/looking*	*Talking*	*Distraction*
Mean (SD)	---	---	---	.05 (.23)	1.76 (.49)	.67 (.91)	1.08 (.83)
Effortful control	4.61 (.50)	-.407*	.175	-.108	-.349*	.225	.045
Attentional shifting	3.96 (.90)	-.180	-.082	.231	-.207	.111	.165
Attention focusing	4.33 (.99)	-.495**	.086	-.191	-.222	.114	-.178
Inhibitory control	4.32 (.74)	-.313*	.050	-.293*	-.139	.338*	.128
Low intensity pleasure	5.20 (.49)	-.373*	.050	.249+	-.335**	.292*	-.192
Perceptual sensitivity	5.17 (.72)	.082	.224	.025	-.210	.130	-.034
Extraversion/Surgency	4.75 (.41)	.192	-.311*	-.025	.137	.057	-.052
Activity level	4.67 (.75)	.104	-.342*	-.013	.400**	.038	.155
Positive anticipation	5.25 (.57)	.242+	-.111	-.217	-.028	-.107	-.058
High intensity pleasure	5.15 (.74)	.283+	-.282+	.153	-.140	.064	.089
Impulsivity	4.58 (.76)	.337*	-.171	.293*	-.071	.277+	-.008
Shyness	3.53 (1.07)	-.137	-.268+	-.096	.441*	-.319*	-.082
Smiling and laughter	5.15 (.70)	.291*	-.114	.115	.072	.291*	.154
Negative affectivity	4.18 (.38)	.037	-.082	-.038	.201	-.202	-.056
Anger/frustration	4.35 (.87)	.154	-.194	.121	.167	-.142	.047
Discomfort	4.01 (.69)	-.166	-.315*	-.051	.276+	-.278+	.132
Soothability	4.57 (.72)	-.050	.018	-.230	-.092	.441**	.202
Fear	3.92 (.71)	.016	.234+	-.025	.347*	-.211	-.029
Sadness	4.07 (.68)	.114	-.186	-.179	-.081	-.272+	-.029
Peabody score	95.15 (19.86)	.066	---	.166	-.037	.155	-.148
Word-learning (total)	1.41 (1.15)	---	.048	.172	-.051	-.055	-.117

****p* < .001,***p* < .01,**p* < .05, +*p* < *.10*

Hierarchical regressions

Word-learning. A series of hierarchical multiple regression equations was computed to assess the univariate and interactive associations between *word-learning*, sociodemographic variables (age, gender and parental education), behavioural scores and temperamental traits of the *effortful control composite* (*attention focusing, Inhibitory control and low intensity pleasure)* and the *extraversion/surgency composite* (*impulsivity* and *smiling and laughter).* These two temperamental traits were selected for the regression analyses based on their conceptual links to *word-learning* as well as on the results of the correlational analyses. The conceptual objective of the regression analyses was to determine if temperament (i.e., children`s reactivity and self regulation) accounted for variance in *word-learning*, beyond the contributions of gender, parental education, and parents' education. As such, variables were entered into the equation in the following order: Step 1, *age, gender, mother education* and *father education*; Step 2, behavioural observations (*pointing, turning head, talking* and *distraction* behaviours); Step 3, *effortful control composite; Step 4, extraversion/surgency composite*. At each step of the regression, the significance in R^2 change is computed to determine if each effect added to the predictiveness of the overall equation.

Results from the analysis are presented in Table 2. As also evidenced in the preliminary analyses, significant effects on *word-learning* were found for temperament; *effortful control* composite (negative effects) and *extraversion/surgency* composite (positive effects). Children's *effortful control* and *extraversion/surgency* composites significantly predicted *word-learning* performance beyond the contributions of gender and parental education. In steps 1 and 2, none of the entered variables (sociodemographic and behavioural scores) accounted for significant variance in *word-learning*. In step 3, *effortful control* accounted for 31.3% of statistically significant unique variance after controlling sociodemographic and behavioural scores. Finally, in step 4, the *extraversion/surgency* composite explained 6.5% of unique variance, though this last result was only marginally significant (p = .08).

Peabody score. A similar rationale was considered to assess the univariate and interactive effects on *Peabody* performance. Sociodemographic variables (age, gender and parental education), behavioural scores and the overall dimension of *effortful control* as well as the subdimension of *discomfort* were included in the hierarchical regressions. This dimension and subdimension were included on the basis of previous correlational analyses. Variables were entered into the equation in the following order: Step 1, gender, mother education and father education; Step 2, behavioural observations (*pointing, turning head, talking* and *distraction* behaviours); Step 3, overall *effortful control; Step 4, discomfort* subdimension.

Results from the hierarchical regression for the *Peabody score* are presented in Table 3. Children's overall dimension of *effortful control* significantly predicted *word-learning* performance beyond the contributions of age, gender and parental education. In steps 1 and 2, none of the entered variables (sociodemographic and behavioural scores) accounted for significant variance in *word-learning*. In step 3, *effortful control* accounted for 13.7% of statistically significant unique variance after controlling sociodemographic and behavioural scores. Finally, in step 4, no significant results were observed regarding the *discomfort* subdimension.

Table 2. Hierarchical Regression Analyses for *word-learning.*

Variables	**R2**	**ΔR2**	**F-change**	**B**	**SEB**	**β**
Block 1	.024	.024	.182			
Age				.029	.048	.118
Gender				-.016	.451	-.006
Mother education				-.091	.266	-.082
Father education				.008	.278	.007
Block 2	.174	.149	1.13			
Age				.020	.048	.082
Gender				-.102	.457	-.042
Mother education				-.479	.343	-.434
Father education				.238	.315	.210
Pointing				1.127	.977	.238
Turning head/looking				-.436	.491	-.192
Talking				.039	.278	.031
Distraction				-.431	.312	-.317
Block 3	.486	.313	14.61*			
Age				.043	.039	.175
Gender				-.152	.368	-.062
Mother education				-.425	.276	-.384
Father education				.330	.255	.291
Pointing				.390	.810	.082
Turning head/looking				-.763+	.404	-.335
Talking				.218	.228	.177
Distraction				-.481+	.252	-.354
Effortful control composite				-1.140**	.298	-.624
Block 4	.552	.065	3.35+			
Age				.030	.038	.124
Gender				-.157	.351	-.064
Mother education				-.441	.264	-.408
Father education				.249	.247	.220
Pointing				.329	.773	.070
Turning head				-.659	.390	-.290
Talking				.114	.225	.092
Distraction				-.507*	.241	-.373
Effortful control composite				-.976**	.298	-.535
Extraversion/surgency composite				.559+	.305	.292

***$p < .001$,**$p < .01$,*$p < .05$, +$p < .10$

6. Discussion

Word-learning and temperament. The general question in this study was whether the role of temperament in a learning task is associated to differences in the learning environment. More specifically, we tested the hypothesis that children with lower self-regulation and higher reactivity traits of temperament would display better word-learning performance in an overhearing task. Evidence suggesting that some reactive characteristics are associated to better learning and that self-regulation is associated to poorer learning was found: *effortful control*, the main indicator of self-regulation, and specific self-regulative traits (*attention focusing, inhibitory control* and *low intensity pleasure*) negatively predicted overall word learning. These results lend support to the alternative view, that reactivity or poor self-regulation can be functional in situations where information is not explicitly directed to the child. Therefore, our results contrast with a body of studies that have outlined the "necessity" and "essential" role of high self-regulative traits for learning.

Although no significant association between the overall dimension of *extraversion/ surgency,* and *word-learning* was found, the temperamental traits of *smiling/laughter* and *impulsivity*) did show significant associations with *word-learning*. On the other hand the subdimensions of *positive anticipation* and *high intensity pleasure* (also constituents of *extraversion/surgency)* showed a marginally significant relation with word-learning, that may be considered, specially as this kind of relations are similar to those observed in previous studies (Dixon & Shore, 1997; Dixon Jr & Smith, 2000).

Behavioural Data. A notable limitation in our study is that behaviours were coded with discrete scores (i.e., 0 or 1) independently if behaviours could have been exhibited several times or for long periods, during the experiment. This limitation may be which may be masking relevant distinctions for the comprehension of the dynamics between learning, behaviours and temperament. In spite of this caveats, some interesting relations between behaviours and some temperamental traits were observed. For example, *activity level, shyness* and *fear* were positively related with *turning head/looking.* Likewise, *inhibitory control, smiling and laughter* and *soothability*, positively predicted *talking*. However, contrastingly to our rationale, none of these behaviours were correlated to *word-learning*, therefore, no behaviours seemed to serve as mediators between temperament and learning. Nevertheless, the effect of behavioural variables on learning manifests itself only in multivariate regressions. This suggests that the learning facilitation effect is not the result of individual behaviours, but rather the result of a complex coordination of factors.

In sum, analyses show that low self-regulation and some reactive characteristics, as well as certain behaviours (e.g., *turning head/looking*), affect *word-learning* in an overhearing situation. However, as suggested, the behavioural variables are in need of a more planned and rigorous procedure, in order to address what mediating mechanism connects temperamental characteristics, behaviour and learning. Curiosity (and its related behaviours) might play a role in facilitating learning, but at this juncture we can only suggest that this is a possible avenue for future investigation.

Peabody scores and temperament. Another piece of evidence consistent with our alternative viewpoint is the analysis of the Peabody test. *Extraversion/surgency* negatively predicted performance on the Peabody test. Thus, children with higher scores on *extraversion/surgency*, including *activity level* showed poorer performance on the Peabody test. This was confirmed both in the correlational analysis and in the hierarchical regression. This contrasts with a more common prediction between *extraversion/surgency* and language, where in general extra*version/surgency* is positively related to language (e.g., Dixon and Shore, 1997; Dixon Jr and Smith, 2000; Paul and Kellogg 1997; Slomkowski, et al., 1992). W*ord-learning* performance, *Peabody scores*, and how they both relate to temperament in this study resembles previous findings (Villarreal & Falcón, 2016) in which *extraversion/surgency* relates to language in two opposite directions. Again, these overall results bring new evidence in favor of a *goodness of fit* perspective. On one hand, high levels of *extraversion/surgency* may seem "optimal" when engaging in "complex" and "dynamic" learning and testing situations as in an overhearing setting. On the other hand, when being tested in more rigid situations (as in the Peabody test) these same temperamental traits seem to be disadvantageous.) Accordingly, further investigation must address not only how temperament differentially affects learning, but also how these temperamental traits influence on how learning is revealed in different testing conditions (see Rieser-Danner, 2003, for distinctions between *testing*, *performance* and *competence* related with individual differences).

Table 3. Hierarchical Regression Analyses for *Peabody score.*

Variables	**R2**	**ΔR2**	**F-change**	**B**	**SEB**	**β**
Block 1	.189	.189	1.69			
Age				-.47	.76	-.109
Gender				-.71	7.23	-.017
Mother education				8.12+	4.26	-418
Father education				-.83	4.46	-.042
Block 2	.305	.116	1.04			
Age				-.46	.72	-.107
Gender				-.81	7.36	-.019
Mother education				12.49*	5.53	.643
Father education				-4.25	5.09	-.214
Pointing				10.45	15.76	.126
Turning head/looking				13.89+	7.92	.347
Talking				2.51	4.48	.116
Distraction				2.32	5.04	.097
Block 3	.443	.137	5.90*			
Age				-.27	.71	-.064
Gender				-1.97	6.75	-.046
Mother education				14.30*	5.11	.736
Father education				-5.85	4.70	-.294
Pointing				7.52	14.46	.090
Turning head/looking				17.41*	7.39	.435
Talking				4.28	4.16	.197
Distraction				1.87	4.61	.078
Extraversion (overall dimension)				-18.48*	7.60	-.388
Block 4	.490	.047	2.12			
Age				-.16	.69	-.037
Gender				-3.92	6.73	-.091
Mother education				15.79**	5.10	.813
Father education				-6.70	4.63	-.336
Pointing				10.31	14.27	.124
Turning head/looking				20.29*	7.48	.507
Talking				2.00	4.35	.092
Distraction				3.52	4.64	.147
Extraversion (overall dimension)				-16.49*	7.56	-.346
Discomfort				-7.23	4.96	-.254

***$p < .001$,**$p < .01$,*$p < .05$, +$p < .10$

Overall, the results are consistent with the hypothesis that low self-regulation and reactivity may be associated to better learning and with the general hypothesis that children's characteristics can yield different effects on language learning in laboratory and more naturalistic settings. Our explanation of the divergent associations between reactivity and the experimental and developmental-index assessments of vocabulary learning in Villarreal et al.'s (2016) study has been put on firmer ground. Whereas experimental assessments indicate that reactivity interacts with an experimental setting by hindering learning, the CDI developmental index may be tapping into a more complex causal route in which reactivity interacts with diverse factors. This shows that the routes in which temperament influences language acquisition can take many and diverse forms. The fact that self-regulation can sometimes hinder language learning gives us grounds to question the standard viewpoint, and to further investigate possible language-learning scenarios in which reactivity can be valuable.

Since our alternative view runs against the widely accepted standard viewpoint, alternative explanations to our findings must be addressed. One such alternative explanation is that the overhearing situation may provide a great deal of distraction to children. Children with fewer self-regulatory resources, faced with the plentiful stimulation of the overhearing situation may simply give up trying to regulate their behaviour, thus freeing their regulatory resources to deploying them in acquiring the information offered by the overhearing setting. By contrast, children with higher self-regulation may have enough resources to inhibit the "overheard distractors" in the environment. However, this inhibition of the "distractors" put these children in a double disadvantage: first, as we have discussed, their self-regulated behaviour would result in missing learning opportunities in the environment. And, second, since these children need to devote resources to inhibit the "distractors", they would have fewer resources to devote to learning. This interpretation, however, does not account for the fact that some indicators of reactivity showed positive associations with learning. Thus, a more plausible interpretation is that the overhearing setting may promote exposure to environmental information for low self-regulated and more reactive children, while also making learning more difficult to self-regulated children.

Another issue is whether our experimental design is realistic; given the fact that it involves instructions such *as* "wait for a minute" which are rare in real-life situations. It is true that our design can be refined to further resemble more naturalistic settings. However, there are contexts in which similar instructions do occur regularly. In the school, children are expected, or even directly told, to remain in their seats, pay attention to class, perform a task, and so on. School, however, is still an environment that is by no means as controlled as a traditional experimental setting. There are plenty of possible distractions in the form of other pupils talking, people coming in or out the classroom, sights from the windows, noises from outside the classroom, and so forth. Thus, the school is an environment that tacitly demands children to self-regulate themselves (see Zhou, Main & Wang for the relation between self-regulation and academic achievement). Taking this into account, an instruction such as "wait for a minute" from the experimenters, is not very different from some real-life contexts in which overhearing situations occur, such as the school. However, the specific contribution of such elements of the experimental design certainly constitutes an open question for future investigation.

Cultural background and its effects on learning in overhearing situations should also be addressed. For example, Rogoff, Paradise, Arauz, Correa-Chávez, and Angelillo (2003) document learning effects associated to differences in cultural background. Children from a "hierarchical style of communication" cultural background tend to learn better from indirect speech. This is the case with Mexican mothers who exhibit a more hierarchical, rather than a collaborative style of communication (Alcala, Rogoff, Mejía-Arauz & Coppens, 2014; Uribe, LeVine, & LeVine, 1993). Thus, it is possible that the learning effects may be the result of differences in cultural background that manifested themselves in children's behaviour and expectations about how to deal with information not directed to them.

Conclusion

To conclude, we must insist on the idea that, as we mentioned in the Introduction, children's characteristics acquire adaptive value when there is a *goodness of fit* (Thomas & Chess, 1977) between them and the environment. Self-regulation is not advantageous in all situations. In this respect, Rothbart and Jones (1998) suggest that schools should take into consideration the fact that different children tend to adapt differently to the environment. The present study has identified one way in which variability in children is functional in promoting linguistic development: in an overhearing setting, highly reactive children possess learning strategies that are more adaptive than the strategies of self-regulated children. Children with different characteristics are capable of developing their own adaptive strategies to deal with the challenges in their environment. In acquiring language, the routes to success are multiple and diverse. Natural tendencies such as the child's reactivity should not be seen as handicaps, but rather as opportunities for the child's individual adaptation.

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