Instituto Universitario de Neurociencia
Universidad de La Laguna

FACULTAD DE PSICOLOGÍA Y LOGOPEDIA

DEPARTAMENTO DE PSICOLOGÍA COGNITIVA, SOCIAL Y ORGANIZACIONAL

INSTITUTO UNIVERSITARIO DE NEUROCIENCIA (IUNE)

The functional role of the inhibitory control neural networks in the comprehension of sentential negation

Tesis doctoral de la Universidad de la Laguna

Bo Liu

San Cristóbal de la Laguna, 2020

El Dr. David Beltrán Guerrero y el Dr. Manuel de Vega Rodríguez, directores de la tesis de Bo Liu titulada "The functional role of the inhibitory control neural networks in the comprehension of sentential negation" aprueban la lectura de dicha tesis al considerar que cumple con las exigencias científicas y formales necesarias para su presentación.

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Presentada por

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Directores:

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Part I. Introduction

Negation is a ubiquitous feature of human language. All languages have negative markers to express a variety of semantic and pragmatic goals. Imperative negations are used to prohibit an action (*don't move*) and are acquired in early childhood as commands to stop intended or ongoing actions. Declarative negations can express absence of actions (*she doesn't speak*), of objects (*there is no bread*), of mental states (*he doesn't know*), etc. Negations can refer to either the absence of semantic relations (*a dauphin is not a bird*) or the absence of episodic states or events (*there is not vaccine yet*), they can be expressed by a separable particle (*I am not happy*), or an affix (*I am unhappy*), and can be used as a tool for reasoning (*There is no bread, so we cannot make sandwiches*). Generally speaking, negations invite the listener/reader to suppress something in their mind: an action, an intention, or an idea. As we will see, the psycholinguistic research suggests that understanding negations induces conceptual inhibition. Yet the neural mechanisms of this inhibition are still poorly understood. This doctoral dissertation uses neurophysiological methods to advance our understanding on the inhibitory processes of negation.

The Reusing Inhibition for Negation (RIN) hypothesis posits that the comprehension of negation reuses the inhibitory control mechanisms (Beltrán et al., 2018; de Vega et al., 2016). However, until now the RIN hypothesis has only been tested in Indo-European languages with alphabetic writing systems, and its applicability was limited to negated action-related sentences and negative imperatives. The current doctoral dissertation aims to consolidate and extend the RIN hypothesis in

several ways. First, testing the generality of the RIN hypothesis to a language with different writing system, such as Mandarin Chinese. Second, extending the RIN hypothesis to other semantic domains of negation beyond action-related sentences and imperatives; for instance, existential negation. Third, examining the bi-directionality of the impacts between sentential negation and response inhibition; namely, how understanding a negative statement modulates the neural activity of an inhibition task, and how a previously established inhibition state modifies the neural activity of sentential negation.

This introductory chapter comprises four sections. **Section 1.1** provides a theoretical background of psycholinguistic research on negation, showing that negation increases the difficulties in statement processing and reduces the activation of concepts under its scope. **Section 1.2** presents a detailed review of the inhibitory effects of negation on meaning representations and memory retrievals reported by previous studies adopting diverse experimental designs and methodologies. **Section 1.3** summarizes the major findings of previous studies investigating human inhibitory control processes, including the paradigms used, the modulations in event-related potentials (ERPs) and time-frequency oscillations (TF), and the brain generators of these effects in EEG signals. **Section 1.4** lists the recent studies providing direct evidence that negation shares neural resources with the inhibitory control processes, according to which the RIN hypothesis was put forward. The second chapter in this dissertation describes the **Objectives and Hypotheses** and summarizes the

experiments that were performed to test them. The third chapter offers a detailed description of the **Experimental Studies** of the dissertation, which gave place to three articles: two already published in international journals and the third one ready for submission. The fourth chapter is the **General Discussion** of the dissertation, which is followed by the final **Conclusions**.

1.1. Theoretical background

Negation is a basic attribute of human language and logic. According to extant knowledge, all human communication systems involve negative representations that are usually achieved by linguistic markers/operators like *no* and *not*, whereas no animal communication system contains similar representations and operations (Horn, 2001). Negative statements enable the speakers to express explicitly that certain properties are not valid for the subjects or situations under discussion (Kaup, 2001). Given its important semantic, pragmatic and logical functions, research on negation receives widespread interest and attention from various research fields, including linguistics, psychology and cognitive science (Christensen, 2020).

The prevalence of negation in psycholinguistic research dates back to the 1960s when researchers showed particular interest in the logic of negation, such that most of the experimental tasks were designed to investigate higher-level cognitive processes involved in logical operations (Carpenter & Just, 1975; Clark & Chase, 1972, 1974; Gough, 1965, 1966; Just & Carpenter, 1971; Just & Clark, 1973; Wason, 1961, 1965;

Wason & Jones, 1963). For instance, by adopting a sentence verification paradigm and utilizing the mutually exclusive classes of odd and even numbers as materials, Wason (1961) found that the time taken to verify a statement describing the parity (odd vs. even) of a number increased significantly if negation was involved (e.g., "*Twenty-four is an even number*" vs. "*Fifty-seven is not an even number*"). The same pattern of longer response latencies for negative trials was also detected in sentence-picture verification tasks (Just & Carpenter, 1971), in which participants were asked to judge whether a picture (e.g., presentation of black dots) conformed to the description of the preceding statement (e.g., "*The dots aren't red*" vs. "*The dots are black*"). In general, these early studies, demonstrating that negation increases processing difficulties across various material types and experimental designs, laid the foundation for future research questions (Kaup & Dudschig, 2020).

MacDonald and Just (1989) took the initiative to investigate the representation of negated concepts in the absence of truth-value computations. They examined the activation level of the negated information with both probe recognition and probe naming tasks and found that negation inhibits (reduces the activations of) negated nouns. More recently, the two-step model of negation processing was proposed to explain the difficulties that negation poses on sentence comprehension and its deactivating/inhibiting effects on the information under its scope (Hasson & Glucksberg, 2006; Kaup et al., 2006; Kaup & Zwaan, 2003; Lüdtke et al., 2008). According to the two-step account, understanding negative sentences (e.g., "*The door*

was not open") first activates representations of the negated/counterfactual situations as what happens to their affirmative counterparts (e.g., "*The door was open*") and then, in a second step, the initial representations are deactivated/inhibited and replaced by the actual state of affairs (e.g., a closed door). Although it is questioned whether the first step is mandatory, claiming that it might be susceptible to pragmatic factors (Nieuwland & Kuperberg, 2008; Orenes et al., 2014; Tian et al., 2016), the two-step model provides plausible explanation to multiple cases of negation processing. Later on, studies within the embodied framework of language comprehension revealed that negation deactivates/inhibits content-specific motor cortices activations and peripheral motor activities, producing a "disembodiment" effect (Bartoli et al., 2013). Empirical evidence comes from studies using various methodologies, including functional magnetic resonance imaging (fMRI) (Tettamanti et al., 2008; Tomasino et al., 2010), transcranial magnetic stimulation (TMS) (Liuzza et al., 2011; Papeo et al., 2016), electromyography (EMG) (Foroni & Semin, 2013), and measurements of kinematic activities and grip force (Aravena et al., 2012; Bartoli et al., 2013). The inhibitory effects of negation will be discussed in more detail in **Section 1.2**.

However, affirmative and negative sentences diverge not only in the number of representations they evoke but also in the processes/mechanisms recruited to handle these representations (Beltrán et al., 2019). Compared to the bulk of studies investigating the consequences of negation on sentence comprehension, research on the neural mechanisms that underlie negation processing itself is sparse, with only a

few recent attempts (Beltrán et al., 2019; Beltrán et al., 2018; de Vega et al., 2016; Dudschig & Kaup, 2018, 2020a, 2020b; Garcia-Marco et al., 2019; Mayo et al., 2014; Wirth et al., 2019). Three processes are proposed by these studies that might be responsible for negation processing: 1) inhibitory mechanisms involved in forgetting (Mayo et al., 2014); 2) inhibitory mechanisms recruited in withholding/stopping actions and responses (Beltrán et al., 2019; Beltrán et al., 2018; de Vega et al., 2016; Garcia-Marco et al., 2019); 3) conflict monitoring mechanisms utilized for action control (Dudschig & Kaup, 2018, 2020a, 2020b; Wirth et al., 2019). The current dissertation aims to enrich the research line on the neural mechanisms underlying negation by providing further evidence on how negation interacts with inhibitory control processes. **Section 1.3** will present a review of studies investigating inhibitory control, and **Section 1.4** will report recent researches exploring the sharing of neural circuitries between the comprehension of negation and the inhibitory control processes.

1.2. Inhibitory effects of negation

As mentioned previously, MacDonald and Just (1989) provided the first piece of evidence regarding the inhibitory effects of negation. In their study, participants read sentences that contained a direct object phrase with two nouns. There were three experimental conditions: 1) Noun 1 negated and Noun 2 affirmed (e.g., "*Almost every weekend, Elizabeth bakes no bread but only cookies for the children*"); 2) Noun 1

affirmed and Noun 2 negated (e.g., "*Almost every weekend, Elizabeth bakes some bread but no cookies for the children*"); 3) none of the nouns was negated (e.g., "*Almost every weekend, Elizabeth bakes some bread and some cookies for the children*"). In the first experiment, the participants received a probe recognition task in which they were asked to judge whether the probe word had appeared in the sentence they had just read. Two negation-induced effects were observed on the probe task reaction times. First, for sentences involving negation (either Noun 1 negated or Noun 2 negated), responses were slower when the probe words corresponded to the negated nouns compared to the non-negated nouns regardless of their positions in the sentences (Noun 1 vs. Noun2). Second, the existence of negation in any place of the sentence (either before Noun 1 or Noun 2) slowed down responses, in that probe task reaction times were significantly longer for the two types of negated sentences than for the non-negated sentences. The second experiment resembled the first one in all respects, except that the probe verification task was replaced by a probe naming task in which the participants were asked to simply read aloud the probe word without having to judge its presence or absence in the preceding sentence. The results showed a similar pattern, with negation slowing responses to the negated nouns regardless of the probe position (Noun 1 vs. Noun2). These findings were consistent with the authors' hypothesis that negation reduced the activation levels of the negated concepts in discourse representation.

Adopting a similar probe recognition paradigm, Kaup (2001) investigated the impact of noun phrase type (indefinite vs. definite) and action type (creation vs. destruction) on the verification of the probe word. In the first experiment, a brief background introduction was followed by a negative sentence which contained a verb denoting a creation action and either indefinite (of the form "*…a Noun 1 but not a Noun 2*"; e.g., "*Sarah is now building a chair but not a table for her uncle*") or definite (of the form "*…the Noun 1 but not the Noun 2*"; e.g., "*After a while he decides to build the castle but not the church*") noun phrases in the object position. The experimental passage ended with a sentence describing the completion of the action without reference to any of the noun phrases. The probe word was one of the nouns mentioned in the negative sentence. Both response latencies and errors indicated poorer performance (i.e., longer reaction times and higher error rates) in the probe task when it contained a negated noun than a non-negated noun regardless of the noun phrase type (indefinite vs. definite). In the second experiment, the passage structure was similar to that of the first experiment. The critical difference consisted in the action type used in the negative sentence, with the inclusion of verbs denoting destruction action, such as "*burn*" rather than "*build*". Given the fact that the negated nouns invariably appeared after the non-negated nouns (of the form "*…Noun 1 but not…Noun 2…*") in the first experiment, it was assumed that the observed negation effects on probe task performance (slower responses and more errors) might be caused by the order of the two nouns in the sentence. To exclude the possibility of advantage-of-first-mention effect on probe task performance, the authors manipulated

the location of negation in the second experiment, where the negated nouns always preceded the non-negated nouns (e.g., "*Peter does not burn the big cupboard but the old bed*"). Still, participants responded significantly faster to the non-negated nouns than to the negated nouns. These results confirmed the inhibitory effects of negation in that it reduced the accessibilities of the negated referents. Note that the reaction time difference between negated and non-negated items was smaller for the destruction passages than for the creation passages, indicating that situational absence enhances the inhibitory effect of negation when describing creation acts but abates it in the context of destruction acts. Such modulatory effect of negation was also corroborated by follow-up studies (Kaup & Zwaan, 2003).

Studies conducted under the embodied cognition framework (Barsalou, 1999; de Vega et al., 2008; Fischer & Zwaan, 2008; Glenberg & Gallese, 2012) provided further and more direct evidence of the inhibitory effects of negation. According to the embodiment theories, language comprehension invokes activations in sensorimotor systems (Anderson & Spivey, 2014; Barsalou, 2016; de Vega et al., 2014; Garcia & Ibanez, 2016; Horchak et al., 2014; Louwerse & Jeuniaux, 2010; Zwaan, 2016). The embodiment effect has been best instantiated by comprehension of action language that activates motor networks and/or motor cortices. Such evidence came from studies using various methodologies, including behavioral (Glenberg & Kaschak, 2002; Zwaan & Taylor, 2006), kinematic (Boulenger et al., 2006; Gentilucci & Gangitano, 1998; Glover & Dixon, 2002), neuroimaging (Aziz-Zadeh et al., 2006;

Hauk et al., 2004; Moody & Gennari, 2010), brain stimulation (Buccino et al., 2005; Cacciari et al., 2011), electrophysiological (Aravena et al., 2010; Moreno et al., 2015), electromyographic (Foroni & Semin, 2009) and neuropsychological (Boulenger et al., 2008; Fernandino et al., 2013; García & Ibáñez, 2014; Kargieman et al., 2014) techniques.

However, the presence of negation diminishes the embodiment effect of action language. Two neuroimaging studies provided initial proofs of the inhibitory effects of negation on motor circuits activations (Tettamanti et al., 2008; Tomasino et al., 2010). According to these studies, affirmative action-related sentences (e.g., "*Now I push the button*") or imperatives (e.g., "*Do grasp*") activated the primary motor and premotor cortices in the brain, whereas such activations were significantly reduced by their negative counterparts (e.g., "*Now not push the button*"; "*Don't grasp*"). The systematic modulation of motor system activations and connection strengths by sentence polarity supports the notion that negation, at least partially, inhibits sensorimotor representations. Using Transcranial Magnetic Stimulation (TMS), Liuzza and colleagues (2011) investigated the impact of negation on cortico-motor reactivity during action language processing. They applied facilitatory paired-pulses Transcranial Magnetic Stimulation (pp-TMS) over the right-hand representation on the left primary motor cortex (M1) of the participants when they passively read both affirmative and negative manual action sentences. The motor-evoked potentials (MEPs) from a right-hand muscle (the First Dorsal Interosseus, FDI) were registered

to examine cortico-spinal activity. They found a reduction of MEP amplitudes for affirmative manual action sentences and an absence of such effect when reading the corresponding negative sentences, suggesting that negation reduces cortico-spinal sensorimotor simulation. Follow-up behavioral studies corroborated these findings (Aravena et al., 2012; Bartoli et al., 2013). Aravena and colleagues (2012) investigated language-induced motor activity by measuring the online grip-force during sentence listening, they observed significant grip force enhancement shortly after the manual action verb onset in affirmative sentences but no grip force enhancement when the same set of action verbs appeared in homologous negative sentences, indicating that negation blocks the recruitment of certain peripheral structures of the motor system during action language processing. The abatement of sensorimotor activity induced by negation led to the assumption that more motor neural resources should be available to perform a concurrent motor task during the processing of negative action sentences compared to affirmative ones. This assumption was qualified by a kinematic study showing that negation attenuated the interference of action language on concurrent and congruent upper limb movements, inducing a disembodiment effect (Bartoli et al., 2013). In this study, affirmative or negative sentences describing proximal movements (e.g., "*I grasp*" vs. "*I [do] not grasp*"), distal movements (e.g., "*I pinch*" vs. "*I [do] not pinch*") or abstract contents (e.g., "*I wish*" vs. "*I [do] not wish*") were used as stimuli. Participants were asked to listen to each sentence and perform a reach-to-grasp task mainly relied upon proximal arm musculature (Experiment 1) or a grasping movement mainly loaded on distal arm

musculature (Experiment 2). Their responses were faster after receiving negative than affirmative sentences describing congruent actions. Specifically, the reach-to-grasp movement was faster for negative versus affirmative proximal sentences, while the grasping movement was faster for negative versus affirmative distal sentences. It could be concluded that negative sentences, compared to their affirmative counterparts, reduced computational load in content-specific embodied representations, thus sparing a greater amount of neural resources for concurrent and congruent motor processes. Finally, an electromyography (EMG) study (Foroni & Semin, 2013) reported the activation of zygomatic muscle when reading affirmative emotional expressions relevant to the activity of this muscle (e.g., "*I am smiling*") and the inhibition of this muscle when reading the corresponding negative sentences (e.g., "*I am not smiling*").

1.3. Inhibitory control

Inhibitory control is one of the core executive functions of human beings. In a broad sense, it consists of the abilities to control one's behavior, attention, emotions and thoughts to overcome internal inclination or external temptation, and perform what's more necessary or appropriate (Diamond, 2013). In the motor domain, it could be defined as the capabilities to override predominant, customary, or spontaneous responses in order to execute more accommodative, target-oriented behaviors (Ilieva et al., 2015). The latter is often called response inhibition, which involves the

suppression of inappropriate, unsafe, or unwarranted behaviors (Chambers et al., 2009). Thus, inhibitory control enables us to make adjustments and choose our reactions and behaviors instead of becoming "unthinking creatures of habit" (Diamond, 2013).

Inhibitory control has commonly been studied using paradigms in which a prepotent motor response is elicited for most trials, while such response has to be inhibited in some cases (Wessel, 2018). The Go/NoGo task and Stop-Signal task are two frequently adopted examples of these paradigms. A typical Go/NoGo task often contains two different types of stimuli representing the Go (i.e., "a yellow dot" or "the letter X") and NoGo (i.e., "a blue dot" or "the letter Y") condition, respectively. The participants are randomly presented with these stimuli and are asked to respond as quickly as possible - often by pressing a button - to a Go stimulus, but withhold the response after the presentation of a NoGo stimulus (Aron, 2011; Menon et al., 2001; Nakata et al., 2014). In many Go/NoGo tasks, Go stimuli account for a dominant percent (e.g., 70%, 75% or even 80%) of all trials to create a strong response tendency which increases demands for inhibitory control (Benikos et al., 2013; Bokura et al., 2001; Kopp et al., 1996). While the Go/NoGo task investigates inhibition of uninitiated responses or the response tendency, the Stop-Signal task targets at inhibition of already started or underway responses. In a Stop-Signal task, participants are instructed to respond as fast as possible by pressing a button after the Go signal onset. A Stop signal - often delivered in auditory form - is presented after the Go

signal for a minority of the trials, for which participants are required to refrain from executing the ongoing response. The timing between the Go signal and the Stop signal is manipulated from trial to trial for each participant as to produce about 50% successful inhibition, allowing to compute the individual Stop Signal reaction time (Chambers et al., 2009; Logan & Cowan, 1984; Verbruggen & Logan, 2008).

EEG studies adopting the Go/NoGo paradigm usually reported two major ERP signatures which are commonly considered as indicators of inhibition-related processes, though they probably represent functionally separable sub-processes. The first one is the fronto-central N2 component that shows more negative amplitudes in NoGo than in Go conditions at about 140-300 ms after the Go/NoGo stimulus onset; the second one is the fronto-central P3 component which displays a more positive-going trend for NoGo than for Go trials at approximately 300-600 ms after stimulus presentation (Bokura et al., 2001; Bruin & Wijers, 2002; Duan et al., 2009; Eimer, 1993; Falkenstein et al., 1999; Falkenstein et al., 2002; Kamarajan et al., 2005; Kopp et al., 1996; Nakata et al., 2014; Roche et al., 2005; Smith et al., 2008; Zhang et al., 2007). The NoGo-N2 component was traditionally viewed as an index of response inhibition (Jodo & Kayama, 1992; Kok, 1986; Kopp et al., 1996) or non-motor inhibitory processes (Falkenstein et al., 1999; Smith et al., 2008). Subsequent studies doubted the role of NoGo-N2 as an index of response inhibition *per se*, favoring instead a conflict-monitoring interpretation (Donkers & van Boxtel, 2004; Enriquez-Geppert et al., 2010; Groom & Cragg, 2015; Randall & Smith, 2011). For

instance, enhanced N2 was evoked by infrequent trials compared to frequent trials regardless of the response type (Go vs. NoGo) and the corresponding inhibitory demand (non-inhibition vs. inhibition) (Enriquez-Geppert et al., 2010). Moreover, in a cued-Go/NoGo task, N2 amplitude increased whenever there was a conflict between the planned response hinted by the cue and the demanded response indicated by the target (i.e., a NoGo target after a Go cue, or a Go target after a NoGo cue) (Randall & Smith, 2011). Nonetheless, neither the inhibition nor the conflict theory overturns the other, and the N2 effect in the Go/NoGo task may reflect either response inhibition or conflict monitoring, or both, depending on the specific task demands. Compared to the either inhibition or conflict interpretation of NoGo-N2 component, the NoGo-P3 is more consistently accepted as a direct indicator of response inhibition (Bruin et al., 2001; Enriquez-Geppert et al., 2010; Gajewski & Falkenstein, 2013; Smith et al., 2006; Wessel, 2018).

The analysis of the EEG signal in the time-frequency domain complements the ERP effects obtained in these response inhibition tasks. Enhanced fronto-central theta power (4-7 Hz) and centro-parietal delta power (1-3 Hz) have usually been detected for NoGo and Stop trials compared to Go trials (Cohen, 2014; Harper et al., 2014; Huster et al., 2013; Nigbur et al., 2011). The former was considered as an index of conflict-related processes involved in inhibiting a dominant motor response, while the later was supposed to reflect response evaluation and/or error detection (Cohen, 2014; Harper et al., 2014; Huster et al., 2013). Augmented fronto-central beta oscillations

were also reported for successful inhibition compared to failed inhibition and Go responses in Stop-Signal tasks, which might also be bound up with the inhibitory control processes (Huster et al., 2013; Swann et al., 2012; Wagner et al., 2018).

Though scalp-recorded EEG could capture electrical voltage fluctuations that reflect inhibitory neural activity with high temporal resolution, it provides insufficient information about the brain localization of such neural activity (Nakata et al., 2014). Therefore, many studies used the functional magnetic resonance imaging (fMRI) technique to identify brain regions involved in inhibitory control processes by measuring changes in blood oxygenation level-dependent (BOLD) signals that are associated with neuronal activity. According to these studies, most conducted using Go/NoGo and Stop-Signal paradigms, the inhibitory neural network is widely distributed in the brain including the anterior cingulate and mid-cingulate cortices (ACC & MCC), the dorsolateral and ventrolateral prefrontal cortices (DLPFC & VLPFC), the pre-supplementary and supplementary motor areas (pre-SMA & SMA), the right inferior frontal gyrus (rIFG) and the inferior parietal lobule (IPL) (Braver et al., 2001; Casey et al., 1997; de Zubicaray et al., 2000; Duann et al., 2009; Garavan et al., 1999; Goldstein et al., 2007; Konishi et al., 1999; Konishi et al., 1998; Li et al., 2006; Liddle et al., 2001; Menon et al., 2001; Mostofsky et al., 2003; Nakata et al., 2008; Rubia et al., 2001; Watanabe et al., 2002). Brain stimulation (Aron et al., 2007; Chen et al., 2009; Obeso et al., 2013) and neuropsychological (Aron et al., 2003; Floden & Stuss, 2006; Picton et al., 2007; Sumner et al., 2007) studies also support

the recruitment of these brain regions in inhibitory control processes. Based on previous findings, the rIFG and SMA/preSMA are regarded as crucial parts of the inhibitory control mechanisms in that they might coordinate inhibition through direct white-matter connections and also via the sub-thalamic nucleus of the basal ganglia (Aron, 2011; Chambers et al., 2009).

1.4. Negation uses inhibitory resources

The studies reviewed in **Section 1.2** are important in revealing the inhibitory effects of negation, showing that it reduces the accessibility of the concept under its scope (conceptual representation) and diminishes motor network activations in negated action sentences (neural activity). Such characterization implies, to some extent, that the inhibitory control processes could be somehow involved in the comprehension of negation. Compared to the bulk of studies showing decreased conceptual representations and neural activities for negated information (**Section 1.2**), research investigating how negation produces such inhibitory effects appears scant with only a few recent exceptions (Beltrán et al., 2019; Beltrán et al., 2018; de Vega et al., 2016; Garcia-Marco et al., 2019; Papeo et al., 2016).

In a brain stimulation study, Papeo et al. (2016) applied single-pulse TMS over the hand representation in the left primary motor cortex (M1) of the participants when they read passively either affirmative or negative action-related sentences (e.g., "*Now I write*" vs. "*I don't write*"). In the first experiment, they found lower motor evoked

potential (MEP) amplitude for negated action verbs than for affirmative ones. In the second experiment, they measured motor inhibitory activity by computing the duration of the cortical silent period (CSP), which correlates positively with the activity of GABAergic inhibitory neurons (Cantello et al., 1992; Schütz-Bosbach et al., 2009). Negated action verbs were found to be associated with longer CSP compared to their affirmative counterparts. The authors concluded that the comprehension of negation involves inhibitory processes.

Using a dual-task paradigm that combined a Go/NoGo task with sentence comprehension, de Vega et al. (2016) directly tested whether the comprehension of sentential negation shares neural mechanisms with response inhibition. In this study, participants read either affirmative or negative (e.g., "*Now you will yes/not cut the bread*") imperative action sentences, while performing a Go/NoGo task. A Go cue which appeared above the verb (e.g., "*cut*") 300 ms after its onset was assigned to 70% of the trials, while the other 30% of the trials received a NoGo cue. Both Go and NoGo trials contained half affirmative and half negative sentences. Analysis of the EEG data showed that the inhibition-related theta oscillations were reduced by negative compared to affirmative sentences in the inhibitory NoGo condition but not in the non-inhibitory Go condition, possibly indicating that negation facilitates response inhibition in the Go/NoGo task by pre-activating the inhibitory processes. To reinforce the likely sharing of neural mechanisms between sentential negation and response inhibition and also to obtain relevant behavioral measures, Beltrán et al.

(2018) adopted a Stop-Signal paradigm which was embedded in affirmative or negative imperative action sentences. After the verb onset, participants were required to select and press a left/right button based on the direction of an arrow shown above the verb. In some cases, they received an audio signal suggesting that they should stop the initiated response. Longer Stop-Signal reaction times were detected for negative than for affirmative trials, indicating that inhibitory processes were less efficient in the former than in the latter. ERP results manifested similar effects, showing larger N1 amplitudes for successful stopping in negative than in affirmative trials. Moreover, the source localization of the N1 component was the inhibition-related rIFG which showed stronger activations for negative than affirmative sentences in successful stopping trials. The ERP and source results indicated that negative sentences demand more inhibitory resources, thus consolidating previous findings that understanding negation involves inhibitory control processes. The Reusing Inhibition for Negation (RIN) hypothesis was proposed based on these initial pieces of evidence, positing that comprehension of negation reuses the inhibitory control mechanisms (Beltrán et al., 2018; de Vega et al., 2016). The RIN hypothesis was motivated by the neural reuse principle, according to which the ancient cognitive circuits could be extended to new cognitive uses while retaining the original but separate functions (Anderson, 2010; Fitch, 2011).

With the same dual-task Go/NoGo paradigm as adopted by de Vega et al. (2016), Beltrán et al. (2019) examined the generality of the RIN hypothesis to sentences

describing mental activities (e.g., "*Now you will yes/not wish a surprise*") other than physical actions. Negative sentences, compared to their affirmative counterparts, were found to selectively reduce the inhibition-related theta power for NoGo trials. Notably, this interaction effect between cue and sentence polarity was statistically similar for action and mental sentences. The results reinforced the RIN hypothesis and confirmed its generality to a certain type of non-physical-action language, indicating possibly that the recruitment of the inhibitory control mechanisms in the processing of negation is domain-general rather than specific to physical action language. The RIN hypothesis was further confirmed by a recent behavioral study targeting at the interplay between negation and inhibition through dynamic writing production, as measured with keyboard-based verb typing (Garcia-Marco et al., 2019). Each trial was composed of two sentences: the first sentence provided a context (e.g., "*There is a contract*"); the second sentence was a complement of the first sentence that might describe manual action, non-manual action or non-action processes, with either affirmative or negative polarity (e.g., "*You do/don't sign it*"). Participants' task was to type as quickly and precisely as possible the target verb after its onset (note that the target verb is the last word of the sentence in Spanish). The two independent variables were verb type (manual action, non-manual action, or non-action) and sentence structure (affirmative or negative); and the two dependent variables were the latencies of motor planning and motor execution, the former was measured from target verb onset to the first keystroke, while the latter was recorded from the first keystroke to the last one. Negation was found to defer the typing execution of effector-congruent

verbs (manual action verbs), indicating that comprehension of negation displays effector-specific inhibitory effects on language production.

Part II. Objectives and Hypotheses

The general purpose of the current thesis is to clarify the functional role of the inhibitory control mechanisms in the comprehension of sentential negation, in order to confirm and extend the RIN hypothesis. Specifically, three questions are asked and examined that could contribute to the reinforcement and extension of previous findings about the recruitment of inhibitory control processes during the comprehension of sentential negation.

2.1 Objective 1. To verify whether the Reusing Inhibition for Negation (RIN) hypothesis applies to a non-Indo-European language, that is, Mandarin Chinese.

To this aim, Experiment 1 was conducted with Chinese participants, adopting the same embedded Go/NoGo paradigm used in previous studies with Spanish participants (Beltrán et al., 2019; de Vega et al., 2016). Logographic Mandarin differs significantly from alphabetic languages in writing systems and phonological rules (Tan et al., 2005). The distinctive linguistic features of Mandarin may account for its different neural underpinnings from alphabetic languages. According to neuroimaging studies, both the left middle frontal gyrus (LMFG) and the right inferior frontal gyrus (rIFG) are involved in the processing of Mandarin Chinese rather than alphabetic languages (Kuo et al., 2001; Tan, Feng, et al., 2001; Wu et al., 2012), which are possibly responsible for the coordination and integration of the unique visual-spatial and phonological analyses of Mandarin (Tan, Liu, et al., 2001; Tan et al., 2003). As reviewed in **Section 1.3**, these two brain regions are also recruited in inhibitory

control processes (Chambers et al., 2009; Nakata et al., 2008). The partial overlap of brain regions managing Mandarin processing and inhibitory control could block the accessibility of inhibitory resources for understanding negation in Mandarin due to resource competition. Therefore, testing the RIN hypothesis in Mandarin could help to clarify its robustness and generalizability. The same embedded Go/NoGo paradigm devised by de Vega et al. (2016) was adopted. Native Mandarin speakers were recruited as participants, who were asked to read either affirmative or negative imperative manual action sentences in Mandarin while performing a Go/NoGo task cued by a yellow/blue dot presented above the verb 300 ms after its presentation. Behavioral data and EEG signals were recorded for the entire trials.

Since the RIN hypothesis is grounded on the principle of neural reuse (Anderson, 2010; Fitch, 2011), it is assumed that the inhibitory control mechanisms are reused for understanding negation regardless of the languages and writing systems involved. Accordingly, the hypotheses of Experiment 1 are as follows:

1. Comprehension of negation in logographic Mandarin also uses inhibitory neural resources as the alphabetical Indo-European languages do.

2. Negation would modulate the inhibition-related processes demanded by NoGo trials in the current embedded Go/NoGo paradigm, possibly in a facilitatory manner as in previous studies (Beltrán et al., 2019; de Vega et al., 2016). The impact of negation on response inhibition might be reflected in modulations of the

inhibition-related ERP or TF signature(s) (e.g., for ERP: N2 and/or P3; for TF: theta and/or delta power) for NoGo trials.

3. The likely generator(s) for the modulatory effect of negation on response inhibition reflected in ERP or TF could be the inhibition-related brain region(s), but not necessarily the LMFG and rIFG since they might be occupied by the processing of Mandarin characters and become less accessible to sentential negation.

2.2 Objective 2. To explore whether the influence between negation and inhibition predicted by the RIN hypothesis is unidirectional or reciprocal. Namely, whether a pre-established inhibitory state also modifies the processing of sentential negation.

For this purpose, Experiment 2 adopted a dual-task paradigm in which a Go/NoGo task preceded the comprehension of both affirmative and negative action-related imperative sentences. Previous studies have provided supporting evidence for the RIN hypothesis by confirming that comprehension of sentential negation modulates response inhibition and motor routines (Beltrán et al., 2019; Beltrán et al., 2018; de Vega et al., 2016; Garcia-Marco et al., 2019). If negation shares neural resources with the inhibitory control processes as predicted by the RIN hypothesis, then it would be reasonable to assume that they interact regardless of the task order. The current experiment was to test whether a preset inhibitory state could also modify the neural processing of sentential negation. The experimental materials

were action-related imperative sentences in both affirmative and negative forms. A typical Go/NoGo task cued by a yellow/blue dot preceded the processing of each sentence. Behavioral measures and EEG signals were recorded for all the experimental trials.

The hypotheses of Experiment 2 are as follows:

1. If there exists mutual influence between sentential negation and response inhibition, then the preset of inhibition induced by the NoGo cue in the foregoing Go/NoGo task could either promote or undermine the processing of the ensuing negative action sentences, which might be reflected in modulations of the classical ERP indicators of sematic integration, such as the N400 (Kutas & Federmeier, 2012).

2. Another possibility is that the comprehension of negative action sentences prolongs the pre-established inhibitory state in NoGo trials. This prolonged inhibition by negation might be manifested in the selective modulation of ERP waveforms for the inhibitory negative trials (NoGo-negative condition) after the polarity operator or the verb onset.

3. In the latter case, the most likely brain source(s) for the modulatory effect found in ERP could be the inhibition-related brain region(s).

2.3 Objective 3. To investigate whether the RIN hypothesis could generalize beyond action-related language and imperative sentences to other semantic

domains of negation. Specifically, whether the comprehension of negation in existential sentences also reuses the inhibitory control mechanisms.

To achieve this goal, Experiment 3 adopted a dual-task paradigm similar to previous studies, where the Go/NoGo task was embedded in affirmative or negative existential sentences instead of action-related or imperative sentences. Most of the previous findings supporting the RIN hypothesis were obtained with manual action sentences in imperative format or with imperative implications (Beltrán et al., 2018; de Vega et al., 2016; Garcia-Marco et al., 2019; Papeo et al., 2016). The only exception is a study using sentences describing mental activities as experimental materials (Beltrán et al., 2019). However, these sentences contained abstract verbs and were also constructed in imperative forms. Given the fact that negative imperatives often serve as signals to restrain or stop performing certain actions (de Vega et al., 2016), the sharing of neural resources between sentential negation and inhibitory control processes as found in previous studies might be, at least partially, caused by the imperative format and connotation of the stimuli. Therefore, it would help to consolidate and extend the RIN hypothesis by testing whether inhibitory resources are also recruited for negation processing in existential sentences which do not refer to any explicit action and are exempt from imperative functions. Still, a dual-task paradigm was adopted with the Go/NoGo task embedded during the comprehension of either affirmative or negative existential sentences. A yellow/blue dot indicating the Go/NoGo cue appeared above the object noun in the current

experiment instead of the verb as in previous studies. Also, probe verification and coherence judgment tasks were added in the current experiment to obtain relevant behavioral data.

The hypotheses of Experiment 3 are as follows:

1. The reuse of inhibitory neural resources for understanding negation might be domain-general rather than content-specific. That is, comprehension of negation in existential sentences also reuses the inhibitory control mechanisms as it does in action-related and imperative sentences.

2. If the RIN hypothesis were generalizable to the existential domain of negation, the inhibition-related EEG signature(s) for NoGo trials (e.g., N2, P3, theta power, delta power) would be selectively modulated by negation. The modulation of negation on inhibition might manifest in a facilitatory manner as in previous studies (Beltrán et al., 2019; de Vega et al., 2016), or it might demonstrate an interfering pattern due to the increased task demand in the current experiment compared to the previous studies.

3. The source localizations of the modulatory effect observed in the EEG signature(s) could be the brain region(s) involved in the inhibitory control processes.

4. Both negation and inhibition might impact performance in the probe verification and coherence judgment tasks. Specifically, longer response latencies and higher error rates might be found for negative and inhibitory trials compared to their affirmative and non-inhibitory counterparts.

Part III. Experimental studies

3.1 Experiment 1

The generalizability of inhibition-related processes in the comprehension of linguistic negation. ERP evidence from the Mandarin language

Publication:

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Abstract: The recently proposed Reusing Inhibition for Negation (RIN) hypothesis posits that the inhibitory control mechanism is reused to understand sentential negation. The RIN hypothesis has only been tested in alphabetic languages, and its novelty requires additional support from non-alphabetic languages, like logographic non-Indo-European languages. This study examined the RIN hypothesis in the context of Mandarin, which has unique linguistic features and neural underpinnings. Participants read either affirmative or negative action-related sentences while performing an embedded Go/NoGo task. Reduced inhibition-related N2 was detected in NoGo-negative compared to NoGo-affirmative condition. Brain source estimation

of the N2 interaction effect revealed strongest activation in the right inferior parietal lobule, a typical inhibition-related brain region. These results confirm the generalizability of the RIN hypothesis, suggesting that comprehension of negation in logographic Mandarin also recruits the inhibitory control mechanism.

Key words: sentential negation; inhibitory control; RIN hypothesis; Mandarin; ERPs

3.1.1. Introduction

Negation, which is common to all human languages, refers to the absence of a concept and can reverse the truth value of sentence meaning (Hasson & Glucksberg, 2006). Early behavioral studies revealed that negation increases the cognitive demand for understanding a sentence and suppresses the accessibility of the information within its scope (Carpenter & Just, 1975; Kaup, 2001; Kaup & Zwaan, 2003; MacDonald & Just, 1989). For example, in the classic study of MacDonald and Just (1989), participants were asked to do a word recognition task immediately after reading sentences like "Almost every weekend, Elizabeth bakes some bread but no cookies for the children" and they responded more quickly to the probe word "bread" than "cookies", indicating that negation renders the negated concept less accessible.

Studies working with action language also reported inhibitory effects of negation on motor network activations. Neuroimaging studies demonstrated that understanding negative action-related sentences reduced both activations and connection strengths of the primary motor and the premotor cortex compared to their affirmative counterparts (Tettamanti et al., 2008; Tomasino et al., 2010). Convergently, a TMS study showed that reading affirmative but not negative manual action language selectively reduced cortico-spinal excitability (Liuzza et al., 2011), indicating the recruitment of motor networks only in affirmative condition. In other words, negation held back the involvement of motor networks in the comprehension of action language. Other studies explored the modulation of peripheral activities by means of online grasp

force (Aravena et al., 2012) and kinematic measures (Bartoli et al., 2013) during the comprehension of action-related sentences, reporting effects on these measures for affirmative rather than negative sentences.

These studies revealed the inhibitory effects of negation on cognitive and neural representations of the negated information, without digging further the underlying neural mechanism of negation processing itself that may trigger the inhibitory effects. One highly possible explanation is that comprehension of negation reuses the inhibitory control mechanism, herein the Reusing Inhibition for Negation (RIN) hypothesis (Beltrán et al., 2018; de Vega et al., 2016; Papeo & de Vega, 2020). The RIN hypothesis relies on the neural principle of reuse, according to which ancient cognitive circuits can be extended to new cognitive functions, while retaining the original ones (Anderson, 2010; Fitch, 2011). The RIN hypothesis was motivated by the following premises: (1) the inhibitory control mechanism operates on motor networks to suppress an action (Johnstone et al., 2007); (2) comprehension of action language activates motor networks (Aziz-Zadeh et al., 2006; de Vega et al., 2014; Moody & Gennari, 2010); (3) negation reduces the involvement of motor networks during action language comprehension (Liuzza et al., 2011; Tettamanti et al., 2008; Tomasino et al., 2010). Therefore, the inhibitory control mechanism is very likely to be reused during negation processing, which may account for the consistently reported negation-induced inhibitory effects.

Only a few studies have tested the RIN hypothesis recently. It was proved that the silent period following transcranial magnetic stimulation on M1 increased for negative action-related sentences compared to affirmative ones, as an index of the inhibitory activity of the GABAergic system (Papeo et al., 2016). Specially relevant for the present research are the EEG studies showing that negative action-related sentences, compared to their affirmative counterparts, reduced the inhibition-related frontal theta rhythms of NoGo trials in a Go/NoGo task (de Vega et al., 2016), and enhanced the inhibition-related N1 component of successful stop trials in a stop-signal task (Beltrán et al., 2018). Furthermore, negation was reported to delay keyboard-based typing execution for manual-action verbs (Garcia-Marco et al., 2019). These studies are compatible with the RIN hypothesis, suggesting that negation in the context of action language reuses neural resources of the inhibitory control network. According to a very recent study performed in our laboratory, the RIN hypothesis could be generalized beyond motor action sentences to mental event domains (Beltrán et al., 2019).

The above studies explored the inhibitory mechanism of negation using Indo-European languages with alphabetic writing systems. Given its novelty, the RIN hypothesis needs to be tested for its generalizability in different languages and writing systems, which can differ from Indo-European languages in their neural demands. Mandarin offers us an opportunity to do so, because of its distinctive linguistic features. For instance, Mandarin characters are composed of strokes or radicals that fit

into a square-shaped space, while alphabetic words are formed by letters; reading tone-based Mandarin entails orthography-to-phonology transformation, whereas reading accent-based alphabetic languages requires grapheme-to-phoneme conversion (Tan et al., 2005). These unique features of Mandarin are not trivial and may contribute to shaping distinctive brain organization in the processing of Mandarin compared to alphabetic languages. Neuroimaging studies have shown that the processing of Mandarin but not alphabetic languages in native speakers selectively activates the left middle frontal gyrus (LMFG) and the right inferior frontal gyrus (rIFG) (Kuo et al., 2001; Tan, Feng, et al., 2001; Wu et al., 2012). Moreover, impaired reading of Mandarin is more associated with the dysfunction of the LMFG instead of the left temporoparietal regions responsible for reading disability of alphabetic languages (Siok et al., 2004). Accordingly, it was suggested that LMFG and rIFG coordinate and integrate the unique phonological and visual-spatial analyses demanded by Mandarin (Tan, Liu, et al., 2001; Tan et al., 2003). Notably, LMFG and rIFG also play critical roles in the inhibitory control mechanism (Chambers et al., 2009; Nakata et al., 2008; Zheng et al., 2008).

The partial overlap of brain regions implementing both Mandarin reading and inhibitory control processes could undermine the applicability of the RIN hypothesis to Mandarin. Specifically, comprehension of negation in Mandarin might not reuse the inhibitory control mechanism, since part of the inhibitory neural resources would be utilized for the visual-spatial computation and orthography-to-phonology encoding

of Mandarin characters, limiting thereby their availability for negation processing. Therefore, testing the generalizability of the RIN hypothesis in Mandarin is highly relevant and could shed new light on how the human brain configures neural resources for the comprehension of negation in non-alphabetic languages.

The present Event-related potentials (ERP) study was conducted to empirically examine the robustness and generalizability of the RIN hypothesis with Mandarin-speaking participants, using the same embedded Go/NoGo paradigm employed by de Vega et al. (2016) with Spanish-speaking participants. In a typical Go/NoGo paradigm, participants are requested to press a button, as quickly as possible to a frequent Go cue and not to respond to a less frequent NoGo cue. ERP studies adopting the Go/NoGo paradigm usually report enhanced fronto-central N2 and P3 in NoGo condition, the former is considered to indicate response inhibition while the latter could reflect performance evaluation, error detection and/or preparation for future trials (Falkenstein et al., 1999; Hoyniak, 2017; Roche et al., 2005). Importantly, the amplitude of the NoGo N2 component, commonly known as a direct indicator of response inhibition, correlates positively with task difficulty (Benikos et al., 2013). Like in de Vega et al.'s (2016) experiments, participants were asked to read and comprehend both affirmative and negative action-related sentences while responding to a visual Go/NoGo cue presented online above the action verb. Language comprehension was measured by answering a probe question after the presentation of the whole trial.

Given that the RIN hypothesis is based on the neural principle of reuse (Anderson, 2010; Fitch, 2011), we suppose it should be applicable to the processing of negation in not only alphabetic Indo-European languages but also logographic Mandarin, despite their different neural demands. If so, we could expect an interaction between negation and response inhibition with our embedded Go/NoGo paradigm. This interaction could materialize in reduced N2 amplitude in NoGo-negative compared to NoGo-affirmative condition, resulting from the facilitation effect of negation on subsequent response inhibition as reported by de Vega et al. (2016).

3.1.2. Materials and methods

3.1.2.1. Participants

A total of 24 undergraduate students (13 females) aged 17-25 (M = 21.5 years) from Liaoning Normal University and Dalian University of Technology participated in the experiment. All participants were right-handed native Chinese speakers with normal or corrected-to-normal eyesight and had no reported history of neurological illness. They gave informed consent and received 50 yuan RMB (about $7) for their participation. One participant was removed from the analysis because of excessive artifacts.

3.1.2.2. Design and materials

A two within-subjects factorial design was adopted: task cue (Go, NoGo) × sentence polarity (affirmative, negative). A total of 240 Chinese imperative sentences were constructed as experimental materials, each in two versions: affirmative and negative. All had similar structures starting with the temporal adverbial '现在' (xianzai; now) right before the polarity operator, either affirmative '请'(qing; please) or negative '别'(bie; don't). The critical manual verb followed closely the polarity operator before the object which was the sentence end. To maintain participants' attention on each part of the sentence, 30 filler sentences were constructed which differed from the experimental sentences in the first word only: '现在' (xianzai; now) was replaced by '稍后' (shaohou; later) in the filler sentences. To ensure that participants paid attention to the meaning of the sentences while doing the Go/NoGo task, 35% of the trials were followed by a recognition task. The recognition sentence could be identical to the foregoing experimental sentence or modified in the polarity, verb or noun part. The identical sentence required a "yes" response, while the modified sentence required a "no" response. Sample experimental, recognition and filler sentences are listed in **Table 1**.

Table 1. Examples of experimental, recognition, and filler sentences with their pronunciations and English translations.

Experimental sentences			
AFF	现在/请/擦/桌子。	Xianzai/qing/ca/zhuozi.	Now/please/wipe/the table.
NEG	现在/别/擦/桌子。	Xianzai/bie/ca/zhuozi.	Now/don't/wipe/the table.
Possible recognition sentences (take affirmative sentence as example)			
Identical	现在/请/擦/桌子。	Xianzai/qing/ca/zhuozi.	Now/please/wipe/the table.
PM	现在/别/擦/桌子。	Xianzai/bie/ca/zhuozi.	Now/don't/wipe/the table.
VM	现在/请/搬/桌子。	Xianzai/qing/ban/zhuozi.	Now/please/move/the table.
NM	现在/请/擦/椅子。	Xianzai/qing/ca/yizi.	Now/please/wipe/the chair.
Filler sentences			
AFF	稍后/请/洗/衣服。	Shaohou/qing/xi/yifu.	Later/please/wash/the/clothes.
NEG	稍后/别/洗/衣服。	Shaohou/bie/xi/yifu.	Later/don't/wash/the/clothes.

Note: PM, VM and NM represent polarity-modified, verb-modified and noun-modified versions of the recognition sentences, respectively.

The experimental sentences were divided into 2 groups: 168 sentences (70%) were assigned to Go trials and the other 72 sentences (30%) were assigned to NoGo trials. The stimuli were divided into three blocks, with each containing 80 experimental sentences and 10 fillers. For each block, 70% of the sentences were Go trials and the remaining 30% of the sentences were NoGo trials. Among the Go and

NoGo trials, half were affirmative and half were negative sentences. Frequency, strokes and imageability of the verbs and nouns were controlled between Go and NoGo conditions as shown in **Table 2**. Statistical testing did not find any significant difference between Go and NoGo homologous words ($p > 0.5$).

Table 2. Mean scores of lexical frequencies, strokes, and imageability of verbs and nouns in Go and NoGo conditions.

	Verb		Noun	
	Go	**NoGo**	**Go**	**NoGo**
Frequency	20.70 (17.32)	21.75 (18.06)	20.68 (28.35)	22.47 (30.14)
Strokes	10.80 (3.27)	10.81 (3.44)	16.80 (4.55)	17.08 (4.62)
Imageability	4.76 (0.43)	4.78 (0.42)	4.77 (0.42)	4.81 (0.40)

Statistical testing did not find any significant difference between Go and NoGo homologous words ($p > 0.5$). Standard deviations are in the parentheses.

3.1.2.3. Procedure

The experiment was conducted in a dimly-lit room which was soundproof and electrically-shielded. The stimuli were programmed and presented with E-prime software on a 24-inch monitor. Participants were seated comfortably in front of the desk at a distance of about 100 cm from the monitor. After receiving instructions, participants were asked to do a practice round containing 30 trials similar to the

experimental ones. After the practice round, participants were given 3 blocks of 80 experimental sentences and 10 fillers. Sentences were presented randomly within each block and the order of the 3 blocks was counterbalanced among participants.

Each sentence began with a 500-ms fixation cross, then the temporal adverbial and the sentence polarity operator were presented one character a time for 300 ms, with each followed by a 200-ms blank. After that, the critical manual verb was presented for 300 ms, then a Go/NoGo cue (a yellow dot for Go trials and a blue dot for NoGo trials) appeared above the verb and stayed for 200 ms. Participants were required to respond as soon as possible to the Go/NoGo cue by pressing "L" on the keyboard with the index finger of the right hand after seeing a yellow dot and withhold the pressing after seeing a blue dot. Reaction times for the Go trials as well as commission and omission errors were recorded for later analyses. The verb stayed on the screen for another 200 ms, and after a 200-ms blank, the noun was presented one character a time for 300 ms with a 200-ms blank in between.

For trials with no recognition task, 1200 ms after the last character, a new trial started. For trials with a recognition task, the last character was followed by a question mark indicating the coming of a recognition sentence, then the sentence appeared and participants were required to make a yes/no judgment by pressing the "1" or "2" key on the keyboard with the left hand. The sentence remained on the screen until participants made a response. Half of the recognition sentences were identical ones that required a 'yes' response, while the other half were modified versions

demanding a 'no' response. Reaction times of correct responses and accuracy data were collected for the recognition task. The temporal sequence of a trial is illustrated in **Figure 1**.

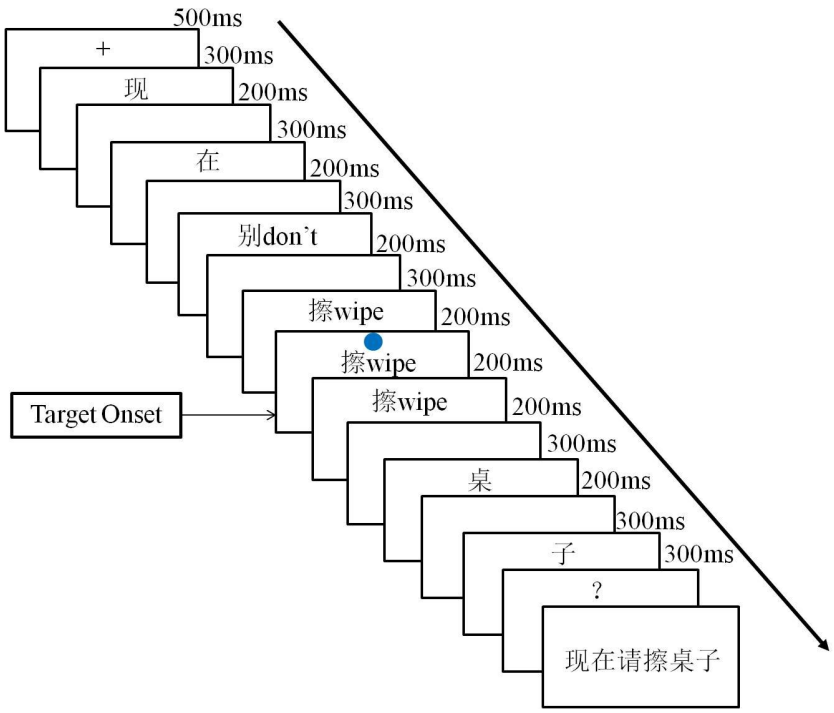

Figure 1. Flow chart of a NoGo trial. EEG recording started at the beginning of the task and ended when participants finished the whole task. ERPs were obtained between 200 ms prior and 800 ms after the onset of the target. The approximate English translation of the sample trial is 'Now don't wipe the table'. The listed recognition question, a polarity-modified version of the trial, can be translated as 'Now please wipe the table'.

3.1.2.4. EEG recording and preprocessing

Continuous electroencephalograph (EEG) signals were recorded by a 64-channel amplifier ANT Neuro EEGO from unshielded and sintered Ag/AgCl electrodes arranged according to the standard 10-20 system on an elastic cap, with two additional electrodes placed on the left and right mastoids (M1 & M2). Two electrodes GND and CPz were taken as the ground electrode and online reference, respectively. Electrode impedances were always kept below 5 kΩ and the sampling rate was 500 Hz. For each trial, ERP recording was time-locked to the onset of the Go/NoGo cue (the yellow/blue dot).

EEG data preprocessing and analysis were conducted using Fieldtrip Toolbox (Oostenveld et al., 2011). Data were re-referenced offline to the average of the two mastoids. Epochs were extracted from 200 ms before to 800 ms after the onset of the Go/NoGo cue, resulting in 1000-ms epochs. Trials with drifting, ocular, or motor artifacts were rejected before analysis. Independent component analysis was conducted to remove the effects of blinks and eye movements. Remaining trials with EEG voltages exceeding 70 μV measured from peak to peak at any channel were also removed.

3.1.2.5. ERP amplitude analysis

To compute the ERPs, artifact-free EEG segments were averaged separately for each of the four experimental conditions using as baseline the 200-ms period preceding the Go/NoGo cue. The resulting ERP waveforms were evaluated statistically using the cluster-based random permutation method implemented in Fieldtrip (Maris & Oostenveld, 2007). This statistical method deals with multiple comparisons in space and time by identifying, over the whole ERP segment (here, 32,000 sample points: 500 time points, from 200 ms prior to 800 ms after cue signal onset, and 64 channels), clusters of significant differences between conditions (sample points in close spatial and temporal proximity) while effectively controlling for type I error.

The RIN hypothesis predicts an interaction between sentence polarity and Go/NoGo cue. Accordingly, our application of the cluster-based randomization approach aimed to identify temporo-spatial ERP clusters in which this interaction reached significance. Since the randomization approach is only applicable to pair-wise comparisons, affirmative minus negative difference waveforms were calculated for each cue condition separately and then compared statistically. Next, to explore the whole design, the significant temporo-spatial clusters were submitted to further analyses. More specifically, for each participant and condition, a single amplitude value was obtained by averaging the temporal and spatial points that made up the identified clusters, and submitting this to a two-way, repeated measures

ANOVA with two cue (Go, NoGo) and polarity (affirmative, negative) as within-subject factors.

3.1.2.6. Source localization analyses

To estimate the likely generator for the interactive effect of the ERPs, source localization was performed using the standardized low-resolution electromagnetic tomography (sLORETA). The sLORETA is a functional imaging method based on certain electrophysiological and neuroanatomical constraints; the cortex has been modeled as a collection of volume elements (voxels) in the digitized Montreal Neurological Institute (MNI) coordinates corrected to the Talairach coordinates (Pascual-Marqui, 2002). For each participant, sLORETA images corresponding to ERP components with significant differences were defined as the mean current density values for the time window of interest and were corrected for multiple comparisons. Statistically significant difference was set to $p < 0.05$.

3.1.3. Results

3.1.3.1. Behavioral results

3.1.3.1.1. Go/NoGo task

Go-trial reaction times in milliseconds were analyzed after removing outliers with scores three SDs above the participants' mean (~1% of Go trials). Sentence

polarity did not produce significant effects on reaction times (affirmative: M = 350.0, SD = 37.4; negative: M = 347.3, SD = 39.5; $t(22) = 1.617$, $p = 0.12$). There was no significant polarity difference on either omission rates in Go trials (affirmative: M = 2.6%, SD = 3.0%; negative: M = 2.0%; SD = 2.3%; $t(22) = 1.100$, $p = 0.283$) or commission rates in NoGo trials (affirmative: M = 5.2%, SD = 6.9%; negative: M = 5.3%; SD = 6.8%; $t(22) = -0.120$, $p = 0.906$). However, there was a main effect of cue on error rates ($F(1, 22) = 4.632$, $p = 0.042$, $\eta_p^2 = 0.168$), namely, commission errors for NoGo trials (M = 5.2%; SD = 6.8%) were more frequent than omission errors for Go trials (M = 2.3%; SD = 2.6%).

3.1.3.1.2. Recognition task

Participants' performance in the recognition task is shown in **Table 3**. There was a main effect of cue on reaction times ($F(1, 22) = 15.314$, $p < 0.001$, $\eta_p^2 = 0.410$), with responses faster for Go than for NoGo trials, but not on error rates ($F(1, 22) = 1.880$, $p = 0.184$, $\eta_p^2 = 0.079$). Polarity produced significant effect on reaction times ($F(1, 22) = 7.561$, $p = 0.012$, $\eta_p^2 = 0.256$), with response faster for affirmative than for negative trials, but not on error rates ($F(1, 22) = 4.126$, $p = 0.054$, $\eta_p^2 = 0.158$). According to subsequent pair-wise *t*-tests: (1) responses were faster for affirmative sentences than for negative sentences in Go trials ($t(22) = -4.402$, $p < 0.001$), but did not differ for NoGo trials ($t(22) = -1.817$, $p = 0.083$); (2) affirmative sentences produced fewer

errors than negative sentences in Go ($t(22) = -3.969$, $p < 0.001$) but not in NoGo condition ($t(22) = -0.976$, $p = 0.338$).

Table 3. Performance in the recognition task.

		Affirmative	Negative
Go	**RT**	890.4 (263.2)	958.3 (309.0)
	ER	4.3 (4.7)	7.8 (5.0)
NoGo	**RT**	942.1 (292.6)	1012.2 (352.9)
	ER	6.5 (6.6)	9.1 (10.9)

Mean reaction times in milliseconds and error rates (ERs) as a function of cue (Go/NoGo) and polarity (affirmative/negative). SDs are shown in parentheses.

3.1.3.2. ERP results

Figure 2 displays waveforms (panel A) and scalp distributions (panel B) of the ERP activities analyzed with the cluster-based random permutation procedure. Analyses of the main effect of cue produced a significant cluster ($T_{maxsum} = 1294$, $p < 0.001$) ranging from 202 ms to 500 ms after cue onset with a fronto-central distribution, covering the time windows of both N2 and P3 components of the Go/NoGo task, demonstrating that the Go/NoGo task was working appropriately in our dual-task paradigm. Tests on the cue × polarity interaction effect resulted in one

significant cluster ($p < 0.05$). This cluster extended between 226 and 290 ms, showing a slightly left-lateralized fronto-central distribution. The subsequent cue × polarity ANOVA for this cluster yielded significant effect of cue ($F(1, 22) = 26.91$, $p < 0.001$, $\eta_p^2 = 0.568$), revealing more negative amplitude for NoGo trials than for Go trials. The timing and the scalp distribution of this effect, along with the direction of the difference, were consistent with the extensively reported enhanced N2 activity for NoGo conditions (Johnstone et al., 2007; Jonkman et al., 2003; Kaiser et al., 2003; Maguire et al., 2009). There was also a cue × polarity interaction effect ($F(1, 22) = 16.83$, $p < 0.001$, $\eta_p^2 = 0.433$), specifically, N2 amplitudes were smaller for negative trials (M = -0.62, SE = 0.45) than affirmative trials (M = -1.63, SE = 0.47) in the NoGo condition ($t(22) = 2.96$, $p = 0.007$), but did not differ in Go condition (Ms = 1.34 and 1.07, SEs =0.63 and 0.61, $t(22) = 1.34$).

In sum, ERP activity of the N2 component discriminated between inhibition (NoGo) and non-inhibition (Go) trials, with N2 amplitudes larger in NoGo than in Go condition. More importantly, reduced N2 amplitudes were detected for NoGo-negative relative to NoGo-affirmative trials, thus confirming the interaction effect between cue and polarity predicted by the RIN hypothesis.

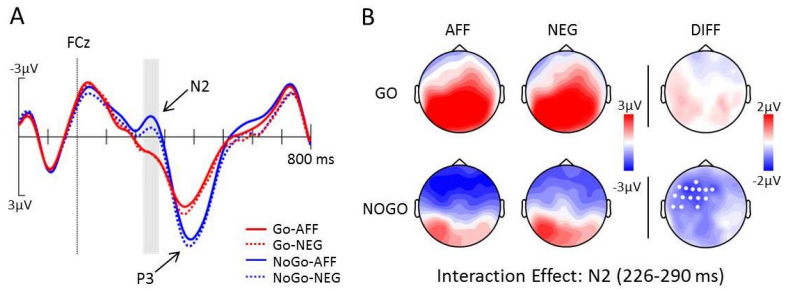

Figure 2. Event-related potentials. (A) Waveforms in one representative electrode (FCz) of the main effect of cue (Go vs. NoGo) in N2 and P3 time windows indicated by the arrows, and the cue × polarity interaction effect in the N2 time window (226-290ms) identified by cluster-based random permutation analysis and shown here as gray-shaded area. (B) Scalp distributions of the ERP activity in the N2 time window for all cue × polarity conditions (Go-affirmative, Go-negative, NoGo-affirmative and NoGo-negative) with difference between polarity conditions shown on the right side (the white dots correspond to the electrodes with significant differences).

3.1.3.3. Source localization results

To better understand the neural processes underlying the interactive inhibition–related effects obtained for the N2 component, standardized low-resolution electromagnetic tomography analysis (sLORETA) was conducted to localize the source of the current densities occurring in the N2 time window in three-dimensional space within the brain. There was a significant cue × polarity interaction effect on

current densities in the N2 time window, with activations being stronger in NoGo-affirmative than in NoGo-negative condition. This difference was maximum at the right inferior parietal lobule (rIPL) in BA 40 as shown in **Table 4** and marked in yellow in **Figure 3**.

Table 4. Brain spatial localization of significant (p < 0.05) affirmative-negative difference in NoGo condition in N2 time window (226-290 ms).

Structure	t-value	MNI coordinates (x, y, z)	Brodmann area
Inferior Parietal Lobule	4.03	40, -50, 60	BA 40

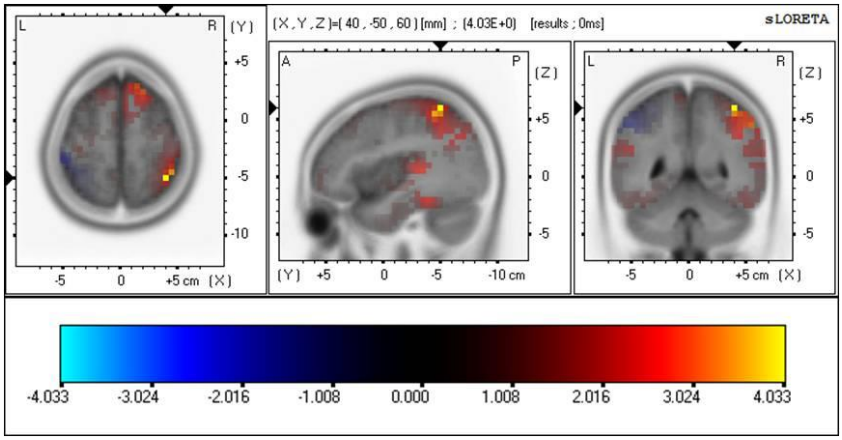

Figure 3. Brain source estimation corresponding to the cue × polarity interaction in the inhibition-related N2 component. The yellow area represents the brain spatial localization of the N2 source in the right inferior parietal lobule (rIPL).

3.1.4. Discussion

The present study was conducted to test the robustness and generalizability of the RIN hypothesis in Mandarin. Participants read to comprehend both affirmative and negative sentences describing manual actions in Mandarin while performing an embedded Go/NoGo task. The results supported that the RIN hypothesis also applies to the comprehension of action-related negation in Mandarin. First, there was an interaction effect of Go/NoGo cue and sentence polarity on N2 amplitudes, a typical indicator of response inhibition (Bokura et al., 2001; Kok, 1986). Specifically, reduced N2 was detected for NoGo-negative compared to NoGo-affirmative sentences. Furthermore, brain source estimation of the N2 interaction effect revealed that the main source of difference was the rIPL, a brain region frequently reported as being involved in the inhibitory control network (Garavan et al., 1999; Goldstein et al., 2007; Nakata et al., 2008; Rubia et al., 2001).

To clarify the modulatory effect of sentential negation on response inhibition, some purely linguistic factors should be excluded. First, sentence length should not be an influential factor, because the words in the affirmative and negative sentences were the same except for the polarity operator. Second, the N2 difference in NoGo condition could not be attributed to the distinctive features of the verbs, because the verbs were the same and the assignment of either affirmative or negative polarity to the verbs was counterbalanced across participants, for both Go (Go-affirmative and Go-negative) and NoGo (NoGo-affirmative and NoGo-negative) trials. Third, the

polarity effect on NoGo N2 was unlikely due to the complexity of processing negative sentences, because negation neither slowed Go reaction time nor produced significant effect on Go N2 amplitudes, and its only influence on behavioral performance was delayed until the recognition task.

In typical Go/NoGo experiments, enhanced N2 component is found for NoGo compared to Go trials, so N2 is traditionally viewed as an index of response inhibition (Bokura et al., 2001; Kok, 1986). Moreover, a positive correlation between NoGo N2 amplitude and the difficulty in inhibiting the prepotent response has been reported (Benikos et al., 2013). In the current study, N2 amplitude was found to be smaller in NoGo-negative compared to NoGo-affirmative condition. Given the fact that the NoGo cue in our study was preceded by the polarity operator and the verb, a likely explanation for the modulatory effect of polarity on NoGo N2 amplitude is that negation presets an inhibitory state by reusing the inhibitory control mechanism, thus reducing the inhibitory demand of the NoGo cue in NoGo-negative compared to NoGo-affirmative condition. In other words, sentential negation 'primes' subsequent response inhibition, lowering the inhibitory load as reflected in reduced N2.

In addition, the brain source estimation of the N2 interaction effect revealed stronger activation in rIPL for NoGo-affirmative relative to NoGo-negative sentences. Neuroimaging studies support the important functional role of rIPL in the inhibitory control network by reporting its recruitment in the inhibition conditions of both Go/NoGo and stop-signal tasks (Garavan et al., 1999; Goldstein et al., 2007; Nakata

et al., 2008; Rubia et al., 2001). Note that the N2 effect in the current study corresponds to the inhibitory process induced by the NoGo cue. Therefore, the modulation of sentence polarity on the N2 source activation could also be explained by the facilitation effect of negation on subsequent response inhibition. Specifically, negation primes the NoGo cue and decreases its inhibitory demand, possibly by pre-activating the inhibitory control mechanism, leading to reduced N2 and lower activation in the inhibition-related rIPL for NoGo-negative condition compared to NoGo-affirmative condition. Taken together, the N2 interaction effect and its estimated source in the inhibition-related rIPL confirm the robustness and generalizability of the RIN hypothesis that comprehension of negation reuses the inhibitory control mechanism, extending its functional scope from alphabetic Indo-European languages to logographic Mandarin.

Concerning the behavioral results, sentence polarity did not yield any significant effect on either Go reaction times or Go/NoGo error rates in the Go/NoGo task due to a virtual ceiling effect. These could help to rule out the possibility that the cue × polarity interaction effect obtained in the current study was due to the complexity of the online processing of negative sentences. By contrast, interactive effects of cue and polarity were detected in the recognition task: performance was better for Go-affirmative than for Go-negative trials but did not differ for NoGo trials, indicating in the former a long-term effect of the conflict between the negation-related inhibition and the Go cue, which persist even after producing the motor response.

Our results are compatible with the findings of de Vega et al. (2016). Adopting a similar embedded Go/NoGo paradigm and Spanish imperatives as stimuli, they found reduced theta oscillations for NoGo-negative compared to NoGo-affirmative trials and interpreted this modulatory effect arguing that negation presets response inhibition reducing the inhibitory demand of the incoming NoGo cue. Given that both theta power and N2 component are accepted indicators of response inhibition (Bokura et al., 2001; Harper et al., 2014; Huster et al., 2013; Smith et al., 2008), the two studies converge to support the RIN hypothesis that processing negation reuses the inhibitory control mechanism. The behavioral results in the recognition task of the two studies are also consistent; namely, both studies obtained better performance for Go-affirmative than Go-negative trials whereas did not find any difference between NoGo-affirmative and NoGo-negative conditions.

In de Vega et al.'s study, the source estimation of the theta difference between NoGo-negative and NoGo-affirmative conditions did not yield any significant cluster, whereas in this study we provided additional evidence by localizing our N2 interaction effect in the rIPL, a well-known inhibition-related region. Notably, we did not find any interactive effect in frontal regions, such as LMFG and rIFG, which play critical roles in the inhibitory control mechanism (Chambers et al., 2009; Nakata et al., 2008; Zheng et al., 2008). There are at least two possible reasons for this absence of effects. The first one is purely technical; the source estimation algorithms applied to EEG data do not provide the detailed neuroanatomical information obtained with the

neuroimaging techniques employed in the above studies, and the neural activity in some regions simply cannot be revealed. The second possibility is more theoretical and was mentioned in the introduction; reading Mandarin characters partially utilizes the inhibition-related regions LMFG and rIFG, and these neural resources become less available to process sentential negation in this language while performing the embedded Go/NoGo task. However, the inhibitory control mechanism consists of a widely distributed network besides the frontal cortex (Nakata et al., 2008), so that other inhibitory resources could still be available to process negation and response inhibition. The modulation of the rIPL activation by negative sentences in the context of inhibitory control (NoGo trials) reported here, confirms that the RIN hypothesis is also valid to explain the processing of negation in Mandarin.

Despite the different linguistic features and processing mechanisms of Indo-European languages and Mandarin, our findings are consistent with previous studies testing the RIN hypothesis (Beltrán et al., 2019; Beltrán et al., 2018; de Vega et al., 2016), and thus contribute to supporting the idea that the neural processes underlying linguistic negation are universal. The connection between imperative negation and response inhibition in both Mandarin and Indo-European languages can be traced back to the early stage of language acquisition, when a mother might use negative imperatives like “don’t touch that” to stop her child from doing some dangerous things (Austin et al., 2014; Wode, 2008). Therefore, the pragmatic function of negative imperatives might be learnt during childhood as stop signals leading to

suppression of actions. The frequent co-occurrence of imperative negations and response inhibition may strengthen the connections between brain regions involved in the lexical representation of negation and those in charge of response inhibition (de Vega et al., 2016), which could explain the N2 modulation and its source localization in the inhibition-related rIPL in the current study.

Further research using neuroimaging techniques would be necessary to examine in detail the neural mechanism shared by sentential negation and inhibitory control, shedding additional light on the roles played by both the motor and the inhibitory control network in sentential negation. Also, the RIN hypothesis must be tested beyond verb phrases or sentences, employing other semantic domains, such as existential negation (e.g. there is no bread). This would help to clarify whether a general-purpose inhibitory control mechanism, rather than one specific for verbs, is operating in the comprehension of sentential negation.

3.1.5. Conclusion

In conclusion, this research examined the robustness and generalizability of the RIN hypothesis in the context of Mandarin action-related language. The RIN hypothesis was supported by the modulation of sentential negation on NoGo N2 amplitudes and the corresponding brain source, namely, reduced N2 was detected in NoGo-negative compared to NoGo-affirmative condition and the estimated source for this effect is the inhibition-related rIPL.

Acknowledgments

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3.2 Experiment 2

Presetting an inhibitory state modifies the neural processing of negated action sentences. An ERP study

Publication:

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Abstract: It has been proposed that understanding negated action sentences (You don't cut the bread) uses the neural networks of action inhibition. The evidence comes from studies in which affirmative or negative action language immediately preceded a Go/NoGo task. It was found that negation selectively modulates inhibition-related signatures of NoGo trials, supporting the Reusing Inhibition for Negation (RIN) hypothesis. To further explore this hypothesis, this study tested the reverse effects; namely, how presetting an inhibitory state affects the processing of negated action sentences. To this end, Go/NoGo responses preceded sentence reading and EEG activities were recorded throughout the entire trials. ERP results indicate that the presetting of inhibition by the NoGo cue induced a sustained modulation of waveform

for negated action sentences relative to affirmative ones, which began shortly after the negation operator onset and remained beyond the action verb onset. Crucially, the estimated sources of such effect were the right inferior frontal gyrus and the left middle frontal gyrus, both relevant regions in the action inhibition circuitry. These results, complemented by previous findings, support the idea that action inhibition and negated action language share neural mechanisms and influence each other, thus confirming and extending the RIN hypothesis.

Keywords: action inhibition; action sentences; sentential negation; Event-Related Potentials; reuse inhibition for negation

3.2.1. Introduction

The embodied approach posits that conceptual representations of language meaning involve activations of specific sensory and motor systems in the brain (Barsalou, 2016; de Vega et al., 2008; Louwerse & Jeuniaux, 2010; Zwaan, 2016). Notably, understanding action-related language activates the motor and premotor cortex to simulate the actions referred to, as was demonstrated by many behavioral (Glenberg & Kaschak, 2002; Zwaan & Taylor, 2006), neuroimaging (Aziz-Zadeh et al., 2006; Hauk et al., 2004; Moody & Gennari, 2010), electrophysiological (Aravena et al., 2010; Moreno et al., 2015), neuropsychological (Boulenger et al., 2008; Fernandino et al., 2013; García & Ibáñez, 2014; Kargieman et al., 2014) and brain stimulation (Buccino et al., 2005; Cacciari et al., 2011) studies. Yet, the representation of negated action language challenges the embodiment view, given the fact that motor simulations seem unnecessary when the absence of an action (e.g. don't press the button) is referred to.

Studies with functional Magnetic Resonance Imaging (fMRI) technique demonstrated that negative action-related sentences, compared to their affirmative counterparts, reduced both activations and connection strengths of the primary motor and the premotor cortex (Tettamanti et al., 2008; Tomasino et al., 2010). Moreover, paired-pulses Transcranial Magnetic Stimulation (pp-TMS) applied to the right-hand primary motor cortex diminished cortico-spinal excitability during the passive reading of affirmative manual action sentences but not their negative counterparts, indicating

that the motor cortex was recruited by the former and its activation was blocked by the latter (Liuzza et al., 2011). Similarly, behavioral studies investigating online grasp force and kinematic measures during comprehension of action-related language also reported less involvement of the motor networks in negative relative to affirmative condition (Aravena et al., 2012; Bartoli et al., 2013). Thus, negation consistently reduces activations in the motor networks when applied to action-related language. Yet, how does negation induce this "deactivation" of concepts under its scope? What mechanisms account for the processing of negation?

The neural mechanism of negation has been recently linked up to general cognitive control networks that are involved in forgetting (Mayo et al., 2014), conflict monitoring (Dudschig & Kaup, 2018) and inhibition (Beltrán et al., 2018; de Vega et al., 2016; Garcia-Marco et al., 2019; Papeo & de Vega, 2020). One of these recent proposals is the Reusing Inhibition for Negation (RIN) hypothesis, which holds that negation reuses general inhibitory control mechanisms (Beltrán et al., 2018; de Vega et al., 2016; Papeo et al., 2016). The RIN hypothesis relies on the principle of neural reuse, according to which ancient neurocognitive circuits can be extended to new cognitive functions, while retaining the original ones (Anderson, 2010; Fitch, 2011). The rationale is that both negation (as reviewed above) and the inhibitory control mechanism (Nakata et al., 2008; Smith et al., 2008) have the function of suppressing previously activated representations; therefore, the inhibitory control mechanism is very likely to be reused for negation comprehension.

The RIN hypothesis was supported by some recent EEG findings, showing that negative action-related sentences (e.g., *Now you will not cut the bread*), compared to their affirmative counterparts (e.g., *Now you will cut the bread*), reduced inhibition-related frontal theta power in a Go/NoGo task, and enhanced early N1 amplitudes in a Stop-Signal task, with the latter effect having an estimated source in the right inferior frontal gyrus (rIFG), a brain region strongly associated with the inhibitory control mechanism (Beltrán et al., 2018; de Vega et al., 2016). Moreover, the RIN hypothesis has been confirmed in Mandarin, which markedly differs from Indo-European languages and writing systems (Liu, Wang, et al., 2020), and it was generalized to non-action-related sentences (Beltrán et al., 2019). Other findings reported in the literature also support the RIN hypothesis. For instance, negation increased the cortical silent period that followed TMS stimulation over the motor cortex, a neurophysiological index of the activity of the inhibitory GABAergic system (Papeo et al., 2016) and it delayed typing execution for manual action verbs, likely reflecting local inhibitory effects of negation on the motor cortex (Garcia-Marco et al., 2019).

Nonetheless, the above studies focused on the effect of negation on subsequent inhibitory processes, revealed by the modulation of inhibition-related markers, such as frontal theta oscillations in response to NoGo trials (de Vega et al., 2016). Yet, the RIN hypothesis predicts bi-directional interactions; namely, comprehension of negation modulates subsequent inhibitory processes as was demonstrated (Beltrán et al., 2019;

de Vega et al., 2016; Liu, Wang, et al., 2020), and also the presetting of inhibitory activity alters the processing of linguistic negation. Therefore, to further evaluate the RIN hypothesis, it seems highly relevant to examine whether comprehension of negated sentences is affected by a preceding inhibitory task. To do this, we adopted a dual-task paradigm that combined a typical Go/NoGo task with a subsequent reading task containing both affirmative and negative manual action sentences. In a Go/NoGo task, participants are asked to respond, often by pressing a button, to a frequent Go cue (e.g., a yellow dot) and not to respond to a less frequent NoGo cue (e.g., a blue dot). ERP studies adopting the Go/NoGo paradigm usually report enhanced fronto-central N2 and P3 in NoGo condition, which are considered as neural signatures of inhibition-related processes (Roche et al., 2005; Smith et al., 2008). In the current study, unlike in previous dual-task experiments with negation (Beltrán et al., 2019; de Vega et al., 2016; Liu, Wang, et al., 2020), each trial started with the Go/NoGo task followed by an action-related sentence with either affirmative or negative polarity. We expect interactive effects with this paradigm, especially when NoGo trials were followed by negative action sentences. Let us consider two possibilities. First, the inhibitory state induced by the NoGo cue could selectively disrupt or facilitate the comprehension of negated action sentences, as might be reflected by the modulation of typical semantic ERP signatures after the polarity word or the verb onset, like the N400 that indicates difficulties of semantic integration (Kutas & Federmeier, 2012). Second, given their sharing of inhibitory resources (RIN hypothesis), understanding negated action sentences might extend the pre-established inhibitory state induced by the NoGo cue

and this prolonged inhibition could be reflected in the differential modulation of ERP amplitudes for NoGo-negative relative to NoGo-affirmative trials, or to any Go trials after the presentation of the polarity word or the verb. In such case, the most likely brain sources for the interactive effects are the inhibition-related brain regions, like pre-supplementary motor area (pre-SMA), right inferior frontal gyrus (rIFG) and left middle frontal gyrus (LMFG) (Aron et al., 2014; Li et al., 2006; Nakata et al., 2008; Swann et al., 2012).

3.2.2. Materials and methods

3.2.2.1. Participants

A total of 27 undergraduate students from the Faculty of Psychology at the University of La Laguna (Spain) participated in this experiment (12 males; mean age 20 years old, range 18-25). All participants gave informed consent and received course credits for their participation. All were neurologically healthy, right-handed, native Spanish speakers and had normal or corrected-to-normal eyesight. Four participants were removed from the analysis due to excessive artifacts (loss of more than 30 percent of the trials), resulting in a final sample of 23 participants.

3.2.2.2. Design and materials

A 2 cue (Go/NoGo) x 2 sentence polarity (affirmative/negative) design was adopted, in which a sentence was always preceded by a Go/NoGo task. Totally, 266 Spanish action-related sentences, referring to manual actions with objects, were constructed as experimental materials, each in two versions: affirmative and negative. Each experimental sentence started with the temporal adverb "ahora" (now) followed by the polarity word (sí/no), then the manual action verb before the article, and finally the noun (**Table 1**). To avoid the continuous repetition of "ahora" (now) and to increase the total amount of the Go trials, 40 filler sentences were included which only differed from the experimental materials in the first word: the adverb "ahora" (now) was replaced by "después" (afterward) or "luego" (thereafter). To maintain participants' attention and collect relevant behavioral data, 36% of the experimental sentences were followed by a recognition task which consisted of a sentence that was either identical to the previous one ("correct" response) or modified by polarity, verb or noun ("incorrect" response). Half of the recognition sentences required "correct" responses, while the other half demanded "incorrect" responses.

Table 1. Examples of experimental, recognition, and filler sentences with their English literal translations in parentheses. PM, VM, and NM represent polarity-modified, verb-modified and noun-modified versions of the recognition sentences, respectively.

Experimental sentences	
Affirmative	*Ahora **sí** cortarás el pan*. (Now you will **yes** cut the bread.)
Negative	*Ahora **no** cortarás el pan*. (Now you will **not** cut the bread.)
Possible recognition sentences (take the affirmative sentence as an example)	
Identical	*Ahora sí cortarás el pan*. (Now you will yes cut the bread.)
PM	*Ahora **no** cortarás el pan*. (Now you will **not** cut the bread.)
VM	*Ahora sí **comprarás** el pan*. (Now you will yes **buy** the bread.)
NM	*Ahora sí cortarás el **queso***. (Now you will yes cut the **cheese**.)
Filler sentences	
Affirmative	*Después sí llamarás al taxi*. (Afterwards you will yes call the taxi.)
Negative	*Luego no comprarás las flores*. (Thereafter you will not buy the flowers.)

The experimental sentences were divided into two groups: 186 Go trials (70%) and 80 NoGo trials (30%). Go and NoGo trials were controlled for lexical factors of the verbs and the nouns, as demonstrated in **Table 2**.

Table 2. Mean scores of lexical frequency, length (number of letters), and imageability of the verbs and the nouns for Go and NoGo trials. Statistical testing did not find any significant difference between Go and NoGo homologous words (t < 1).

	Verb		Noun	
	Go	**NoGo**	**Go**	**NoGo**
Frequency	1.03	1.06	0.99	1.04
Length	6.13	6.14	6.20	5.39
Imageability	3.77	3.82	3.80	3.96

3.2.2.3. Procedure

During the experiment, participants were seated in a dimly-lit and soundproof room in a comfortable chair at a distance of about 85-100 cm from the computer screen. They were guided to read an instruction before being given a practice block of 19 trials. The formal experiment started when the participants could successfully complete the practice (fast response and high accuracy). It contained 3 blocks of trials: block 1 and block 2 consisted of 101 trials with 88 experimental sentences (44 affirmative and 44 negative) and 13 filler sentences (7 affirmative and 6 negative); block 3 consisted of 104 trials with 90 experimental sentences (45 affirmative and 45 negative) and 14 filler sentences (7 affirmative and 7 negative). In each block, trials were presented randomly, with 70% of them involving a Go cue and the remaining 30% a NoGo cue. Block orders

were counterbalanced among participants. Trials were programmed and presented using E-prime software (version 2.1; Psychology Software Tools).

Each trial started with a fixation cross on the center of the screen that remained for a period randomly assigned between 500-900 ms. Then a yellow or blue dot, serving as a Go or NoGo cue, appeared above the fixation cross and stayed for 300 ms. Participants were required to press button "2" of a gamepad with the right thumb as soon as they saw the Go cue, and to refrain from pressing after a NoGo cue. The fixation cross remained on the screen for another 700 ms before the sentence started. Each sentence was presented word by word on the center of the screen, with each word lasting 300 ms except the critical verb that stayed 500 ms. There was a 200-ms blank screen between successive words. Participants were instructed to read each sentence carefully to deal with the possible recognition task. For trials with a recognition task, a question mark appeared for 500 ms after the last word of the sentence to indicate the coming of the task. The recognition sentence disappeared after participants made a response or after 4000 ms. Participants were asked to press as soon as possible the button "5" with the left index finger for a "correct" response and button "6" with the right index finger for an "incorrect" response. The next trial began after an interval of 1500 ms. **Figure 1** illustrates a sample trial. Response time and accuracy were recorded for both the Go/NoGo task and the recognition task.

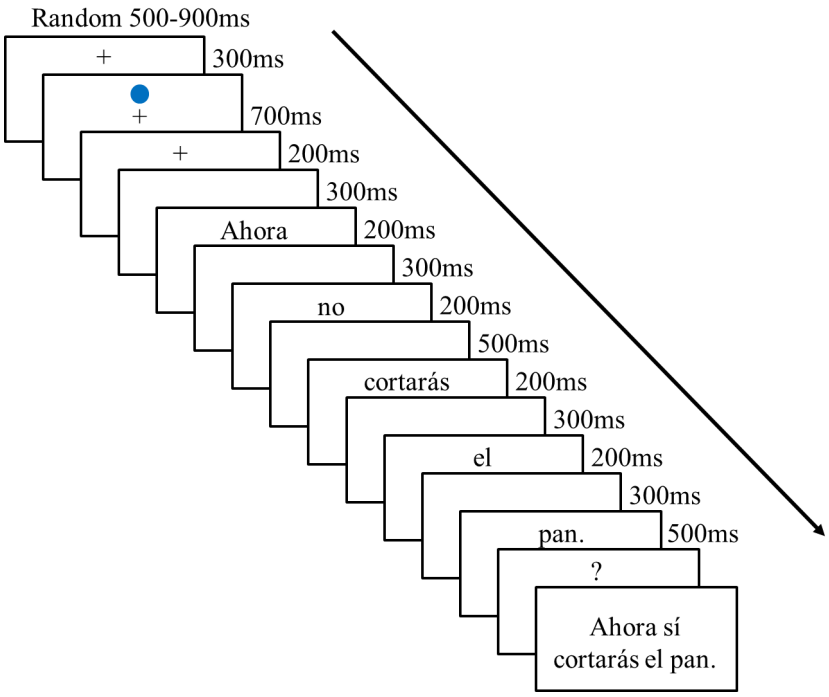

Figure 1. Outline of a NoGo trial. The English translation of the sample sentence is 'Now you will not cut the bread'. The listed recognition sentence is a polarity-modified version of the trial, which can be translated as 'Now you will (yes) cut the bread'.

3.2.2.4. EEG recording and preprocessing

EEG and EOG signals were recorded using Ag/AgCl electrodes mounted in elastic Quick-caps (Compumedics). EOG signal was measured from two bipolar channels: one from two electrodes placed at the outer canthus of each eye and the other from two

electrodes above and below the left eye. EEG signals were recorded from 60 electrodes arranged according to the standard 10–20 system, with additional electrodes placed at on the left and right mastoids (M1/M2). All EEG electrodes were referenced online to an electrode at vertex and re-referenced offline to an average reference. EEG and EOG signals were amplified at 500 Hz sampling rate using Synamp2 amplifier (Neuroscan; Compumedics), with high- and low-pass filters set at 0.05 and 50 Hz, respectively. EEG electrode impedance was kept at < 5kΩ.

EEG data preprocessing and analysis were conducted using Fieldtrip Toolbox (Oostenveld et al., 2011). Trials with drifting, ocular, or motor artifacts were rejected by visual inspection before analysis. Independent component analysis was applied to the data to remove the effects of blinks and eye movements. Remaining trials with EEG voltages exceeding 70μV measured from peak to peak at any channel were also removed.

3.2.2.5. ERP analyses

Clean EEG data were segmented in epochs starting 200 ms before the Go/NoGo cue and extending 2900 ms beyond (700 ms after the verb onset). The 200-ms period preceding the Go/NoGo signal onset was used as baseline. EEG epochs were then averaged in four conditions resulting from combining cue type and sentence polarity: Go-affirmative, Go-negative, NoGo-affirmative, NoGo-negative. The resulting ERP waveforms were evaluated statistically using the cluster-based random permutation

method implemented in Fieldtrip (Maris & Oostenveld, 2007). This method deals with the multiple comparisons in space and time by identifying, over the whole ERP segment, clusters of significant differences between conditions (sample points in close spatial and temporal proximity) while effectively controlling for type I error.

Given this method works only for pairwise comparisons, certain prior calculations were performed to evaluate the main effect of cue in the Go/NoGo task and the cue x polarity interaction after the polarity word onset. Regarding the main effect of cue, affirmative and negative trials were averaged for each cue condition and each participant, and comparisons were performed afterwards using the two types of average files. Concerning the cue x polarity interaction, affirmative minus negative difference waveforms were computed for each cue separately and then these difference waveforms were compared statistically.

The temporo-spatial clusters of the interactive effects identified in the previous step from the comparison between difference waveforms were selected for further statistical analysis. Specifically, for each participant and experimental condition, a single amplitude value was obtained by averaging the temporal and spatial points that formed the cluster of interest, and submitted to two-way, repeated measures ANOVAs with 2 cues (Go and NoGo) and 2 polarities (affirmative and negative) as within-subjects factors.

3.2.2.6. Source localization analyses

To estimate the likely brain sources for the interactive effects at the scalp level, source localization was performed using Brainstorm (Tadel et al., 2011). EEG data were co-registered with a standard anatomical template (ICBM152) and boundary element head models were constructed with OpenMEEG (Gramfort et al., 2010). Source activities were estimated for each cue x polarity condition using sLORETA (Pascual-Marqui, 2002) with unconstrained source orientations. For each participant, differences between the source maps of negative and affirmative conditions were calculated for each cue separately and then statistically compared to detect possible interaction effects between cue and polarity. ROIs were created for sets of neighboring solution points showing significant difference ($p < .05$) and mean absolute values of their corresponding current densities were exported for further statistical analysis using 2 x 2 ANOVAs.

3.2.3. Results

3.2.3.1. Behavioral results

3.2.3.1.1. Go/NoGo task

The average reaction time for Go trials was 338 ms (SD = 48). Paired samples *t*-test did not show any main effect of cue on error rates between Go (mean = 1.92%) and NoGo (mean = 2.39%) conditions ($t(1, 22) = .778$, $p = .441$, Cohen's $d = .115$).

3.2.3.1.2. Recognition task

Behavioral data of the recognition task are shown in **Table 3**. For the recognition task, we performed 2 cue (Go and NoGo) x 2 polarity (affirmative and negative) repeated-measures ANOVAs on reaction times and error rates. There was a main effect of cue on both reaction times ($F(1, 22) = 8.076$, $p = .009$, $\eta^2_p = .269$) and error rates ($F(1, 22) = 7.29$, $p = .013$, $\eta^2_p = .246$), with better performance in Go than in NoGo condition. Polarity also produced significant effect on reaction times ($F(1, 22) = 5.552$, $p = .028$, $\eta^2_p = .202$) but not on error rates ($F(1, 22) < 1$). Finally, the cue × polarity interactions did not reach significance for either reaction times ($F(1, 22) < 1$) or error rates ($F(1, 22) = 2.176$, $p = .154$, $\eta^2_p = .09$).

Table 3. Reaction times (in milliseconds) and error rates (in percentage) for the recognition task. SDs are shown in parentheses. Statistical analyses indicated a main effect of cue on both RTs and ERs and a main effect of polarity on RTs ($p < .05$).

	RT	ER
GoAFF	1206 (247.5)	5.2 (6.1)
GoNEG	1243 (273.4)	5.6 (7.2)
NoGoAFF	1242 (301.1)	7.9 (6.9)
NoGoNEG	1278 (283.0)	5.8 (8.5)

3.2.3.2. ERP results

3.2.3.2.1. Comparison between Go and NoGo trials

A long time window was selected for analyses, covering the period from the Go/NoGo cue onset till the sentence onset (0 to 1.2 seconds). Three significant clusters ($p < .005$) were detected when Go and NoGo trials were compared using the cluster-based random permutation method. The first and the second cluster extended consecutively from 0.13 s to 0.47 s after the Go/NoGo cue onset and both showed fronto-central distributions. As illustrated in **Figure 2**, the timing, the directions of waveform differences and the topographical distributions of the two clusters were consistent with the extensively reported enhanced N2 and P3 activities for NoGo trials compared to Go trials (Bokura et al., 2001; Jonkman et al., 2003; Maguire et al., 2009), indicating that the Go/NoGo task that preceded sentence comprehension was functioning properly. The third cluster started at 0.518 s and endured till 1.2 s after the Go/NoGo cue onset. This cluster also manifested a fronto-central topographical distribution, with the waveform less positive in NoGo than in Go condition (**Figure 2**), possibly reflecting a sustained inhibition state induced by the NoGo cue (i.e. the late effect of the Go/NoGo task).

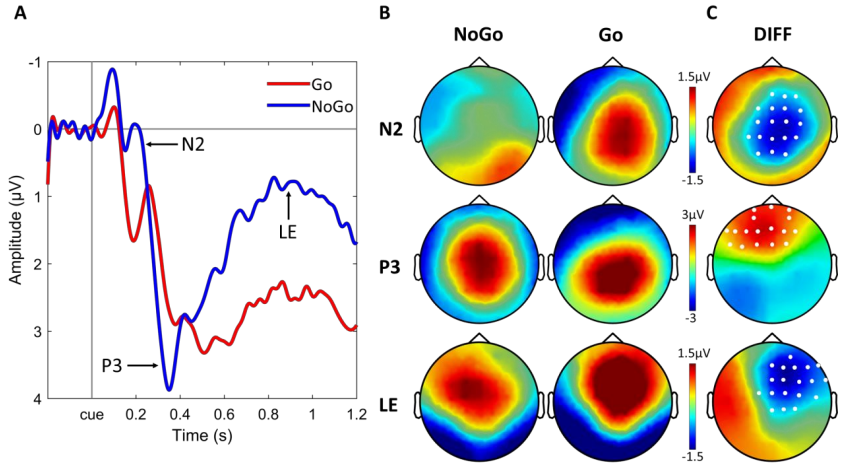

Figure 2. Event-related potentials of the Go/NoGo task. (A) Average waveforms of the significant main effects of cue in a representative electrode (FC2) in the 0-1.2 s time window after the Go/NoGo cue onset. (B) Topographical distributions of the ERP activities corresponding to N2, P3 and the late effect (LE) for both Go and NoGo trials. (C) Differences between NoGo and Go trials in N2, P3 and LE components of the ERPs. The white dots correspond to electrodes with significant difference.

3.2.3.2.2. Analysis of Cue x Polarity Interaction

The EEG data of the trials in each experimental condition were standardized using the 0.2 s period preceding the Go/NoGo cue onset as baseline. The pre-cue baseline was selected because it enabled a complete view of how the inhibitory state developed before the sentence onset and how the cue x polarity interaction unfolded

after the polarity word onset. Statistical analyses to detect cue x polarity interactive effects by means of the cluster-based comparisons between difference waveforms yielded a long significant cluster ($p < .05$) in the 1.2-2.9 s time window after the Go/NoGo cue onset. This time window corresponded to the period from the sentence onset till 0.7 s after the verb onset. The long significant cluster extended from 1.828 s after the Go/NoGo cue onset (i.e., 0.128 s after the polarity word onset) till the end of the epoch (0.7 s after the verb onset and 2.9 s after the Go/NoGo cue onset), showing a right-lateralized fronto-central distribution. The average waveforms in the representative electrodes: F2, F4, F6, FCZ, FC2, FC4, C1, CZ, C2, CPZ and CP2 are shown in **Figure 3A**, and the corresponding topographical distributions appear in **Figure 3B.** The subsequent cue x polarity ANOVA analyses on the mean values for the clusters revealed a main effect of cue, with the positive waveforms showing larger amplitudes for Go than for NoGo trials ($F(1, 22) = 6.207$, $p = .021$, $\eta^2_p = .220$). The main effect of polarity was also significant ($F(1, 22) = 7.328$, $p = .013$, $\eta^2_p = .250$), showing a more positive trend of the waveforms in affirmative relative to negative condition. Importantly, there was also a cue x polarity interaction effect ($F(1, 22) = 7.292$, $p = .013$, $\eta^2_p = .249$). Specifically, the ERP waveforms were more positive for NoGo-affirmative compared to NoGo-negative trials ($t(1, 22) = 3.469$, $p = .002$, Cohen's d = .723), while no such effect was found between Go-affirmative and Go-negative conditions ($t(1, 22) = .605$, $p = .551$, Cohen's d = .126). Average waveform amplitudes in cue x polarity conditions in the cluster time window are presented in **Figure 3C.**

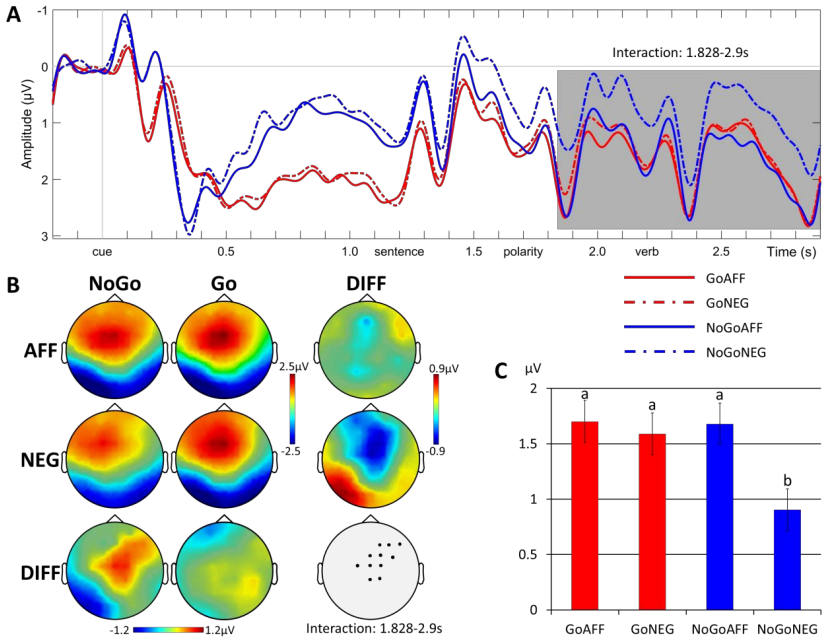

Figure 3. ERP results of the cue x polarity interactive effect during sentence processing. (A) Average waveforms of the cluster identified by random permutation method (1.828 - 2.9 s), the cue x polarity interactive effect is highlighted in gray background. (B) Topographical distributions in all cue x polarity conditions, with difference between NoGo and Go trials in each polarity condition shown on the right side and difference between affirmative and negative trials in each cue condition presented at the bottom (the dots correspond to electrodes with significant difference). (C) Mean amplitude values for each condition in the interactive cluster (means with a different letter are statistically different while means sharing a letter are equivalent).

3.2.3.3. Source localization results

To better understand the neural processes underlying the sustained cue x polarity interactive effects obtained in the ERP waveforms, source localization analysis was conducted, using as input amplitude mean values in every electrode for the cluster time window of the interaction effect. Two significant ROIs were obtained, one in the left middle frontal gyrus (LMFG) and the other is the right inferior frontal gyrus (rIFG), as demonstrated in **Figure 4**. Further statistical analyses of the averaged current densities at each ROI yielded a main effect of cue in both LMFG ($F(1, 22) = 13.33$, $p = .001$, $\eta^2_p = .377$) and rIFG ($F(1, 22) = 5.386$, $p = .03$, $\eta^2_p = .197$), with stronger activations in NoGo compared to Go condition. Polarity did not produce significant effects on either LMFG ($F(1, 22) = 1.221$, $p = .281$, $\eta^2_p = .053$) or rIFG ($F(1, 22) = 1.414$, $p = .247$, $\eta^2_p = .06$). Critically, there were cue x polarity interactive effects in both LMFG ($F(1, 22) = 4.803$, $p = .039$, $\eta^2_p = .179$) and rIFG ($F(1, 22) = 5.579$, $p = .027$, $\eta^2_p = .202$). Specifically, brain activations were stronger in NoGo-negative relative to NoGo-affirmative condition (LMFG: ($t(1, 22) = 2.129$, $p = .045$, Cohen's $d = .444$); rIFG: ($t(1, 22) = 2.386$, $p = .026$, Cohen's $d = .498$)), whereas no significant difference was found between Go-negative and Go-affirmative trials (LMFG: ($t(1, 22) = -1.423$, $p = .169$, Cohen's $d = -.297$); rIFG: ($t(1, 22) = -.779$, $p = .444$, Cohen's $d = -.162$)).

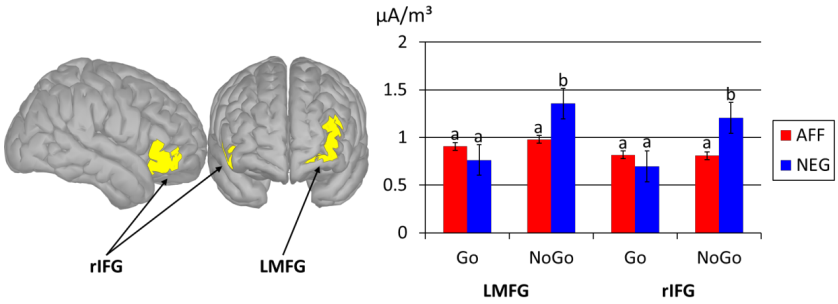

Figure 4. Source estimation corresponding to the cue x polarity interaction in ERPs (1.828-2.9 s). Left: Brain localizations of the two ROIs showing interaction effects: left middle frontal gyrus (LMFG) and right inferior frontal gyrus (rIFG). Right: Mean current densities for each cue x polarity condition in the identified ROIs. Means with a different letter are statistically different, while means sharing a letter are equivalent.

3.2.4. Discussion

The novelty of the RIN hypothesis requires adding new evidence to support the hypothetical inhibitory mechanism that underlies linguistic negation. The current study is the first one to explore whether presetting an inhibitory state selectively affects brain activities in the subsequent processing of negated action sentences. In line with the RIN hypothesis, we found an interaction between the Go/NoGo cue and the sentence polarity on the ERPs after the polarity word and the action verb onset. Specifically, under the inhibitory state induced by the NoGo cue, the average ERP waveform was

less positive for negative than for affirmative action sentences, while no such polarity effect was found in the absence of prior inhibition, that is, after the Go cue. Additionally, source estimation analyses of this interaction demonstrated that negative action sentences elicited more inhibition-related LMFG and rIFG activations than their affirmative counterparts when preceded by a NoGo cue. Below we provide a more detailed discussion about these results.

The major difference between the current experimental paradigm and those adopted in the previous EEG studies is the order of the two tasks included in the trials. Namely, in the previous studies the Go/NoGo cue appeared after the verb onset to test how negation modulates the inhibition processes (Beltrán et al., 2019; de Vega et al., 2016; Liu, Wang, et al., 2020), whereas here the Go/NoGo task preceded sentence comprehension to verify how previous inhibition affects the processing of negated action sentences. We should note that, in this study, during the Go/NoGo task carried out before the sentence presentation, there were differential modulations in amplitudes of the typical inhibition-related ERP signatures N2 and P3 (Falkenstein et al., 1999; Roche et al., 2005; Smith et al., 2008), demonstrating that the task was functioning properly. Moreover, after the P3 there was a significant negative-going waveform for NoGo trials, suggesting a state of sustained inhibition (**Figure 2**). This prolonged inhibition had consequences on the processing of the incoming action-related sentences. In particular, a more negative-going waveform that was exclusively associated with NoGo-negative trials indicates a selective impact of the preset inhibition on the

processing of negative action sentences (**Figure 3**). Purely linguistic factors could be excluded as the cause of this interaction: 1) sentence length should not be an influential factor since affirmative and negative action sentences differed only in the polarity word; 2) lexical factors, such as frequency, length, and imageability of the verbs and nouns for Go and NoGo trials were strictly controlled for the experimental materials; 3) the assignment of either affirmative or negative polarity to the verbs was counterbalanced across participants; 4) no semantic or word-knowledge violations were involved in either affirmative or negative sentences that could result in varied difficulties of sematic integration.

The relative reduction of the ERP waveform amplitude for negative sentences compared to affirmative ones in the context of NoGo cue clearly indicates that action inhibition and negated action sentences share neural mechanisms and influence each other. This interaction can be explained in at least two alternative ways. One possible explanation is that the pre-established inhibitory state induced by the NoGo cue modulates the semantic processes of negated action sentences, either in an interfering (due to competition for inhibitory resources) or a facilitating (due to inhibitory priming) manner. However, this possibility seems unlikely because we did not find any differential modulation among conditions in the semantic-related components of the ERPs (e.g. N400). An alternative explanation is that the processing of negated action language contributes to keep or extend the preset inhibitory state. The selectively more negative-going trend in the waveform starting shortly after the polarity word onset and

extending beyond the verb presentation in NoGo-negative condition supports this interpretation. Consistently, the fronto-central distribution of the cue x polarity interaction partially overlaps the topographical distributions of the N2 and P3 components, and critically, the electrodes showing such interaction are completely included in the cluster of the sustained late effect of the preceding Go/NoGo task. This suggests that the neural networks of action inhibition might contribute to the ERP modulations during the comprehension of negated action sentences.

The source localization for the ERP interaction effect in the LMFG and rIFG provides further evidence in favor of the "extended inhibition" explanation. Neuroimaging, neuropsychology and TMS studies consistently reported the involvement of LMFG and rIFG in inhibition-related processes, with the rIFG playing a critical role (Aron et al., 2003; Fu et al., 2008; Li et al., 2006; Nakata et al., 2008; Rubia et al., 2001; Siebner & Rothwell, 2003; Swann et al., 2012). According to these authors, inhibitory processes are probably coordinated by the rIFG and the SMA/preSMA through direct white-matter connections, and also via the sub-thalamic nucleus of the basal ganglia (Aron et al., 2007; Chambers et al., 2009). In the current study, more inhibitory resources in LMFG and rIFG were employed in the identified time window during the comprehension of negated action sentences rather than their affirmative counterparts when preceded by a NoGo cue, while no such disparity in demand for inhibitory resources was observed between affirmative and negative trials after a Go cue. This might imply that understanding negated action sentences reuses the neural

networks of action inhibition, thus extending the inhibitory state initially induced by the NoGo cue.

Like in most typical Go/NoGo tasks, more trials were assigned to Go (70%) than NoGo (30%) condition in the current study, in order to create a prepotent tendency to respond and a strong demand for inhibition (Bokura et al., 2001; Johnstone et al., 2007). The unequal number of trials may entail different attentional demands in Go and NoGo conditions (Chambers et al., 2009), which could exert potential influences. Further studies are needed to exclude possible attentional biases caused by the unbalanced Go-NoGo ratio. However, the cue x polarity interaction effect in ERPs found in the current study was unlikely due to the different proportion between the Go and NoGo trials. First, affirmative and negative action sentences appeared with equal frequency after both Go and NoGo cues. Second, there was no significant difference in ERP waveform amplitudes between NoGo-affirmative trials and both polarity types of the Go trials in the interaction time window.

Concerning the behavioral measures, the high accuracy in both the Go/NoGo (>97%) and the recognition (>92%) tasks indicates that participants were paying full attention during the experiment. The main effect of cue in performance in the recognition task was consistent with previous studies adopting similar dual-task paradigms (Beltrán et al., 2019; de Vega et al., 2016; Liu, Wang, et al., 2020), suggesting an advantage of processing Go trials over NoGo trials.

Our study considerably extends and reinforces the RIN hypothesis by showing, for the first time, that action inhibition interplays with the processing of negated action language when the motor inhibition task precedes the sentence comprehension task. It also extends the embodied approach to language by explaining how negation, a pure grammatical abstract operator, reuses inhibitory brain resources of the motor system. Previous studies revealed that negation induces "disembodiment" effects during the comprehension of action language (Aravena et al., 2012; Bartoli et al., 2013; Liuzza et al., 2011; Papeo & de Vega, 2020; Papeo et al., 2016). This study provides strong evidence that a possible neural mechanism underlying these negation-induced disembodiment effects is the recruitment of the action inhibition networks which suppress or hinder the motor processes generally involved in the comprehension of affirmative action sentences.

Despite its relevant theoretical implications, the current study provides an incomplete view concerning how the comprehension of negated action language could be modulated by an inhibitory state. The stimuli adopted in the current study were simple affirmative and negative sentences in an imperative form that could be easily understood, and this may account for the lack of interaction effect in sematic ERP signatures, such as the typical semantic N400 effect (Kutas & Federmeier, 2012). Future studies are needed to unveil how the processing of affirmative and negative action sentences is influenced by a preset inhibitory state when semantic or word-knowledge violations are involved.

3.2.5. Conclusion

This is the first study to explore how action inhibition interacts with the comprehension of negated action language using a dual-task paradigm in which a typical Go/NoGo task precedes the processing of either affirmative or negative action sentences. Affirmative and negative sentences did not yield any differential effect in non-inhibitory context. However, understanding negative action sentences preceded by an inhibitory state induced a robust more negative-going ERP waveform, compared to understanding affirmative action sentences. This remarkable ERP interaction along with its fronto-central distribution and its source localization in the inhibition-related LMFG and rIFG suggests that processing negated action language extends the pre-established inhibitory state induced by the NoGo cue. In conclusion, our results consolidate and extend the RIN hypothesis that comprehension of negation in action language reuses the action inhibition mechanisms regardless of the task order.

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3.3 Experiment 3

Existential negation modulates inhibitory control processes. Evidence from ERP and source localization data[1]

Abstract: It has recently been proposed that comprehension of sentential negation involves the reuse of neural inhibitory control mechanisms. However, this Reusing Inhibition for Negation (RIN) hypothesis has mostly been confirmed with imperative sentences which are only a subset of the possible negative statements, and additional support is needed from other semantic and pragmatic domains of negation. The current ERP study examined whether neural inhibitory resources are also recruited during the comprehension of negated existential sentences, which are purely declarative and do not allude to explicit actions. Participants read either affirmative or negative existential sentences (e.g., "*There are already/no apples in the fridge*") while performing an embedded Go/NoGo task. In comparison with affirmative sentences, negation was found to increase the P3 amplitude for NoGo trials, with estimated sources in the inhibition-related SMA/pre-SMA and mid-cingulate cortex. These results indicate that, like negation in action-related imperatives, negation in existential sentences also reuses the inhibitory control mechanisms, consolidating and extending the RIN hypothesis.

[1] The manuscript for this experiment is ready for submission.

Key words: negation, existential sentences, inhibitory control, RIN hypothesis, ERPs

3.3.1. Introduction

Negation is a universal syntactic tool in human communication and reasoning tasks. Recent studies investigating the neural mechanisms of negation proposed the Reusing Inhibition for Negation (RIN) hypothesis, claiming that comprehension of sentential negation reuses the inhibitory control mechanisms (Beltrán et al., 2018; de Vega et al., 2016). However, most of these studies confirmed the RIN hypothesis with imperative sentences describing either manual (e.g., "*Now you will [not] cut the bread*") or mental (e.g., "*Now you will [not] wish a surprise*") actions (Beltrán et al., 2019; Beltrán et al., 2018; de Vega et al., 2016; Liu, Gu, et al., 2020; Liu, Wang, et al., 2020). Imperative sentences are usually used as commands or requests to perform actions, and negative imperatives (e.g., "*Don't move!*") are often taken as signals to refrain from performing the corresponding actions (Aarts, 1989; Tomasino et al., 2010). It is possible that the observed interactions between negation processing and inhibitory control processes could be partially attributable to the imperative format of the experimental sentences, since negative imperatives might serve similar functions to NoGo cues or Stop signals. To extend the RIN hypothesis, additional support from other domains of negation beyond imperatives is needed, to determine whether the hypothetical inhibitory control processes are generally involved in the comprehension of sentential negation. To this aim, this article examines negative existential sentences (e.g., "*There are no apples in the fridge*"), thus avoiding the imperative format as well as action-related contents.

The inhibitory effects of negation date back to early behavioral studies showing that negation reduced the accessibility of the negated concepts (Kaup, 2001; Kaup & Zwaan, 2003; MacDonald & Just, 1989) and also attention to them (Orenes et al., 2014). Taking advantage of action language, several researches confirmed the inhibitory effects of negation, by means of central and peripheral measures of neural activities. In this way, neuroimaging studies have shown that understanding negated action sentences decreased both activations and connection strengths of motor cortices compared to their affirmative counterparts (Tettamanti et al., 2008; Tomasino et al., 2010). Brain stimulation experiments found reduction of cortico-spinal excitability by affirmative but not negative action sentences, suggesting that negation inhibits cortico-spinal sensorimotor simulations (Liuzza et al., 2011). Behaviorally, negation was also found to diminish online grip force enhancement induced by affirmative action language (Aravena et al., 2012), and attenuate the interference of action language on concurrent and congruent upper limb movements (Bartoli et al., 2013).

These studies provided convergent evidence demonstrating the inhibitory effects of negation on cognitive and neural representations of semantic meaning. Such characterization of negation justifies the assumption that processing negation somehow utilizes the neural inhibitory control mechanisms. Yet, inferring the recruitment of the inhibitory control mechanisms from the negation-induced abatement of neural activations is not entirely justified (Papeo & de Vega, 2020), pending further corroboration from studies directly testing the sharing of neural mechanisms between negation comprehension and general-domain inhibitory control

mechanisms. The first pieces of evidence for the functional role of the inhibitory control networks during negation processing came from brain stimulation (Papeo et al., 2016) and EEG studies (Beltrán et al., 2018; de Vega et al., 2016). It has been reported that TMS applied over the motor cortex (M1) decreased motor excitability while increased cortical silent period duration, which is positively correlated with the activity of GABAergic inhibitory neurons (Schütz-Bosbach et al., 2009). Taking advantage of these effects, TMS was applied over M1 when participants understood affirmative or negative action sentences and it was found that negation not only reduced motor activities, but also increased the silent period, which suggests recruitment of inhibitory mechanisms (Papeo et al., 2016).

Importantly, two EEG studies adopting dual-task paradigms provided direct and consistent evidence of shared neural resources between negation processing and response inhibition, as indicated by reduced inhibition-related theta oscillations in a Go/NoGo task (de Vega et al., 2016) and enhanced inhibition-related N1 amplitude in a Stop-Signal task (Beltrán et al., 2018) for the inhibitory-negative trials, with the likely generator of the latter component localized in the right inferior frontal gyrus, a typical inhibition-related area. The RIN hypothesis was thereby proposed, positing that comprehension of negation reuses the inhibitory control mechanisms (Beltrán et al., 2018; de Vega et al., 2016). Recently, this hypothesis has been proved to generalize beyond manual action sentences to mental action sentences (Beltrán et al., 2019) and beyond Indo-European languages with alphabetic writing system to Mandarin Chinese with logographic writing system (Liu, Wang, et al., 2020).

Moreover, bi-directional influences between negative action language and response inhibition have also been found, confirming an important prediction for any resource sharing hypothesis (Liu, Gu, et al., 2020). Finally, it has been reported that negation either facilitates response inhibition in Go/NoGo tasks (Beltrán et al., 2019; de Vega et al., 2016; Liu, Wang, et al., 2020) or interferes with it in a Stop-Signal task (Beltrán et al., 2018), suggesting that the consequences of resource sharing between negation and inhibition vary as a function of task demands. Specifically, negation facilitates inhibition in less demanding inhibitory tasks (Go/NoGo task), whereas it interferes with inhibition when task demands are higher (Stop-Signal task).

To further increase the generality of the RIN hypothesis, it is necessary to test it in other semantic and pragmatic domains beyond action-related language and imperative contents. In the current study, we examined for the first time the RIN hypothesis with existential negations, such as "*There are no apples in the fridge*". These statements are purely declarative and express the absence of objects in static scenarios, without explicitly mentioning any action, either physical or mental. A dual-task paradigm similar to the ones used in previous studies (Beltrán et al., 2019; de Vega et al., 2016; Liu, Wang, et al., 2020) was adopted, in which the Go/NoGo task was embedded in affirmative or negative existential sentences. Unlike in the previous dual-task studies, here each sentence was followed by a probe verification task to obtain behavioral measures of the impacts of negation on the activations of the negated objects (Kaup, 2001; Kaup & Zwaan, 2003; MacDonald & Just, 1989). Also, 40% of the trials contained a coherence judgment task to ensure participants' attention

and to promote deep understanding of the contents. In a Go/NoGo task, participants are often requested to respond to a frequent Go Cue and withhold the response after a less frequent NoGo Cue. EEG studies consistently reported an increase in fronto-central N2 and P3 amplitudes for NoGo compared to Go trials, so that these two ERP components are commonly accepted as neural signatures of inhibition-related processes (Bokura et al., 2001; Cheng et al., 2019; Smith et al., 2008). Furthermore, time-frequency analyses of the EEG data often obtained stronger fronto-central theta power for NoGo trials, possibly indexing the conflict monitoring processes involved in inhibition of prepotent motor responses (Cohen, 2014; Huster et al., 2013).

If the RIN hypothesis applies to the understanding of existential negation, we could expect interactions between existential negation and response inhibition demanded by NoGo trials. Specifically, negation would modulate the inhibitory control processes in either a facilitatory or an interfering manner. A facilitatory effect might be manifested in reduced N2 and/or P3 for negative relative to affirmative inhibitory trials, while an interfering effect might be reflected in enhancement of such inhibitory neural signatures. In either case, the most likely generators of the ERP modulations could be the inhibition-related brain regions, like the anterior cingulate and mid-cingulate cortices, the supplementary motor area complex (pre-SMA and SMA proper), and the right inferior frontal gyrus (Chambers et al., 2009; Nakata et al., 2008). Although it adopted an embedded Go/NoGo paradigm similar to the previous studies, the current study involved additional probe verification and coherence

judgment tasks, making it more demanding than those studies (Beltrán et al., 2019; de Vega et al., 2016; Liu, Wang, et al., 2020). Therefore, in the current study it is predicted that the interaction between negation and inhibition could be one of interference rather than facilitation, possibly reflected in larger N2 and/or P3 amplitudes for negative inhibitory trials than for their affirmative counterparts.

3.3.2. Materials and methods

3.3.2.1. Participants

A total of 28 undergraduate students from the University of La Laguna participated in this experiment (18 females; mean age 18.4 years old, range 17–21). All participants were neurologically healthy, right-handed native Spanish speakers with normal or corrected-to-normal eyesight. They gave informed consent and received course credits for their participation. Four participants were removed from the analyses because of excessive number of artifacts (in more than 30% of trials), thus 24 participants were retained for the analyses.

3.3.2.2. Design and materials

A 2 Cue (Go/NoGo) x 2 Sentence Polarity (affirmative/negative) repeated-measures experimental design was employed. A total of 240 sentences were created: 120 used for experimental trials and 120 for filler trials. The experimental materials consisted of existential sentences in Spanish, each in two versions:

affirmative and negative. All the experimental sentences conformed to the same structure: adverb indicating Polarity + existential verb + object noun + preposition + article + place noun, for example, "*Ya/No hay manzanas en la nevera*" [*There are already/no apples in the fridge*] or "*Ya/No tienen peras en la mesa*" [*They already/don't have pears on the table*]. A probe task followed each experimental sentence, in which the object noun was presented in uppercase, such as "*MANZANAS*" [*APPLES*]. The participants were asked to make a "yes/no" judgment depending on whether the probe word had appeared in the preceding sentence. All the experimental trials required a "yes" response for the probe task. To promote participants' deep understanding of the sentence meaning, 40% of the experimental trials and 20% of the filler trials contained a coherence judgment task after the probe task. This consisted of a new sentence for which the participants were asked to decide whether it was a sensible continuation of the preceding experimental sentence. Half of the coherence judgment sentences required "yes" responses, while the other half demanded "no" responses. A pre-test was conducted with 30 native Spanish speakers, who did not participate in the EEG experiment, to examine the materials used for the coherence judgment task. The results showed that for each sentence, the majority of the participants gave correct answers (Mean: 96.8%, SD: 4.6%; ranging 86.7% - 100%), according to the pre-established coherence criterion. The 120 experimental sentences were divided into 4 trial conditions resulting from the Cue x Polarity combinations; namely, 30 Go-affirmative, 30 Go-negative, 30 NoGo-affirmative and 30 NoGo-negative trials. The four trial categories were counterbalanced, producing 4

blocks of materials to which participants were randomly assigned. Examples of the experimental materials are shown in **Table 1**.

The 120 fillers (60 affirmative and 60 negative), with the same sentence structure as the experimental ones, were created for the following reasons: 1) to reach a proportion of 70% Go - 30% NoGo in the total recount of Go/NoGo trials; to do so, 108 fillers (54 affirmative and 54 negative) were assigned to Go trials and the remaining 12 fillers (6 affirmative and 6 negative) to NoGo trials, resulting in altogether the 240 trials: 120 experimental trials and 120 fillers, among which 168 were Go trials and 72 NoGo trials in each counterbalanced block; 2) to add 96 "no" responses to the probe task since all the experimental sentences required "yes" responses; specifically, 72 of the "no" fillers (36 affirmative and 36 negative; 60 Go and 12 NoGo) involved a probe word that was related to the object noun in the sentence (e.g, "*TIGERS*" for the sentence "*They already have lions in the zoo*"), the other 24 "no" fillers are described below; 3) to avoid that participants strategically paid attention to only the object nouns; to this end, 48 probes in the fillers were place nouns, among which 24 were "yes" fillers (12 affirmative and 12 negative), including as probe a place noun that had appeared in the preceding sentence (e.g., "*CAVE*" for the sentence "*There are already bears in the cave*"), and 24 were "no" fillers (12 affirmative and 12 negative) containing a place noun that was not presented in the preceding sentence (e.g., "*BUS*" for the sentence "*They already have suitcases in the train*"). Examples of the fillers are shown in **Table 1** with the experimental materials.

Table 1. Examples of experimental and filler sentences with their probe words (English translations in parentheses). Also, examples of coherence judgment sentences following the experimental sentences are shown. AFF-coherent means a judgment sentence that is coherent with the affirmative version of the experimental sentence. NEG-coherent means a judgment sentence that is coherent with the negative version of the experimental sentence. O-modified means a probe word that is semantically related to the object noun in the filler sentence, P-identical means a probe word that is the place noun appearing in the filler sentence and P-modified means a probe word that is semantically related to the place noun in the filler sentence.

Experimental sentences		**Probe words**
Affirmative	**Ya** hay velas en el pastel.	VELAS
	(There are **already** candles on the cake.)	(CANDLES)
	Ya hay baterías en el cajón.	BATERÍAS
	(There are **already** batteries in the drawer.)	(BATTERIES)
Negative	**No** hay velas en el pastel.	VELAS
	(There are **no** candles on the cake.)	(CANDLES)
	No hay baterías en el cajón.	BATERÍAS
	(There are **no** batteries in the drawer.)	(BATTERIES)
Coherence judgment sentences		
AFF-coherent	Enciende las velas y canta la canción de cumpleaños.	
	([He/She] lights the candles and sings the birthday song.)	
NEG-coherent	Sale a comprar baterías para el despertador.	
	([He/She] goes out to buy batteries for the alarm clock.)	
Filler sentences (take affirmative sentence as an example)		**Probe words**
O-modified	Ya tienen **leones** en el zoológico.	TIGRES
	(They already have **lions** in the zoo.)	(TIGERS)
P-identical	Ya hay osos en la **cueva**.	CUEVA
	(There are already bears in the **cave**.)	(CAVE)
P-modified	Ya tienen maletas en el **tren**.	AUTOBÚS
	(They already have suitcases on the **train**.)	(BUS)

3.3.2.3. Procedure

During the experiment, participants were seated in a comfortable chair in a dimly-lit room at a distance of about 75-90 cm from the computer screen. They were guided to read an instruction before receiving a practice round of 10 trials that were similar to the experimental ones. The stimuli were programmed and presented with E-prime software (version 2.1; Psychology Software Tools) on a 24-inch monitor. The participants were asked to remain relaxed and minimize blinking and body movements during the practice and the subsequent experiment. The formal experiment began after the participants completed the practice and were clarified with any possible misunderstanding. There were 3 lists of 80 trials (56 Go and 24 NoGo) for each participant. Sentences were presented randomly within each block and participants could have a rest between two consecutive lists. The allocation of participants to each of the 4 experimental blocks (described in the *Design and materials* part) was counterbalanced.

A sample trial is illustrated in **Figure 1**. The sentence was presented word by word, for 300 ms each word except the object noun that remained 700 ms on the screen. A 200-ms blank interval was set between consecutive words. A yellow or blue dot, indicating Go and NoGo Cue respectively, appeared above the object noun 300 ms after its onset. The participants were asked to press the "2" button with the right thumb on the joystick as soon as possible after seeing a yellow dot, but to refrain from responding after a blue dot. The probe word was presented 1000 ms after the end of

the sentence, for which participants should make a "yes"/ "no" response by pressing the "5" or "6" button on the joystick, respectively. For sentences with a coherence judgment task, a question mark appeared after the probe task to indicate the upcoming of the coherence judgment sentence, which was responded with the same "yes" / "no" buttons. The inter-trial interval was set at 2000 ms.

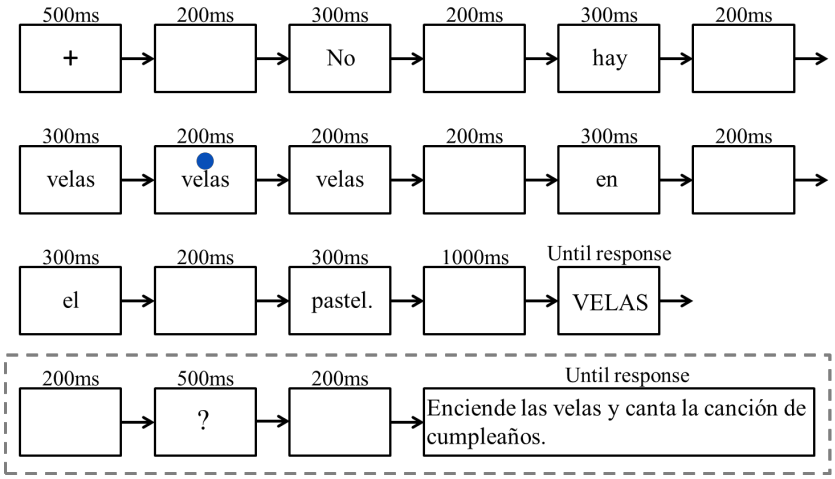

Figure 1. Outline of an experimental trial with a negative sentence that received a NoGo Cue (blue dot). The English translation of the sample experimental sentence is "*There are no candles on the cake*". Forty percent of the experimental trials contained a coherence judgment task as shown in the gray dash-lined box. The English translation of the sample judgment sentence is "*[He/She] lights the candles and sings the birthday song*" which is semantically incoherent with the preceding experimental sentence.

3.3.2.4. EEG recording and preprocessing

EEG and EOG signals were recorded using Ag/AgCl electrodes mounted in elastic Quick-caps (Compumedics). EOG signal was measured from two bipolar channels: one from two electrodes placed at the outer canthus of each eye and the other from two electrodes above and below the left eye. EEG signals were recorded from 60 electrodes arranged according to the standard 10-20 system, with additional electrodes placed on the left and right mastoids (M1/M2). All EEG electrodes were referenced online to an electrode at vertex and re-referenced offline to linked mastoids. EEG and EOG signals were amplified at 500 Hz sampling rate using Synamp2 amplifier (Neuroscan; Compumedics), with high- and low-pass filters set at 0.05 and 100 Hz, respectively. EEG electrode impedance was kept at < 5kΩ. EEG recording was time-locked to the onset of the Go/NoGo Cue.

EEG data preprocessing and analyses were conducted using Brainstorm (Tadel et al., 2011). After being imported, raw EEG files were low-pass filtered at 50Hz and re-referenced to the average of the two mastoids. Ocular components were detected with the "detect eye blinks" function and removed by the SSP algorithm (Signal-Space Projection). Epochs were extracted starting from 200 ms before the Go/NoGo Cue onset and extending 800 ms beyond. Trials with drifting, ocular, or motor artifacts were rejected by visual inspection, and trials with EEG voltages exceeding 70μV measured from peak to peak at any channel were also removed. The

percentages of the excluded trials in the Cue x Polarity conditions are: Go-affirmative (6%), Go-negative (6%), NoGo-affirmative (8%), NoGo-negative (8%).

3.3.2.5. ERP analyses

Artifact-free EEG segments were standardized using the 200-ms period preceding the Go/NoGo Cue as baseline and then averaged separately for each of the four Cue x Polarity experimental conditions (i.e., Go-affirmative, Go-negative, NoGo-affirmative, NoGo-negative). We focused on the N2 and P3 components which are commonly reported and accepted indicators of inhibition-related processes in Go/NoGo tasks (Nakata et al., 2014; Pires et al., 2014). Since both components show fronto-central topographical distributions (Bokura et al., 2001; Donkers & van Boxtel, 2004; Wessel, 2018), time windows of the two components were selected for further analyses after visual inspection of Go and NoGo topographies and the average waveforms in FZ, FC1, FCZ, FC2 and CZ, five representative electrodes in the medial fronto-central brain region. Next, the average waveform amplitudes of these fronto-central electrodes in the identified N2 and P3 time windows for each Cue x Polarity condition were exported for each participant and then submitted to a 2 Cue x 2 Polarity repeated measures ANOVA for statistical comparisons.

3.3.2.6. Source localization analyses

To give a glimpse of the likely neural generators of the ERP effects observed at the scalp level, source estimation was conducted using Brainstorm (Tadel et al., 2011). EEG data were co-registered with a standard anatomical template (ICBM152) and boundary element head models were constructed with OpenMEEG (Gramfort et al., 2010). Brain source activities were estimated for each experimental condition using sLORETA (Pascual-Marqui, 2002). Then, they were statistically analyzed by comparing with permutation-based *t*-test between the two Polarity conditions for NoGo trials based on the ERP results. To control the risk for false positives due to multiple comparisons, regions of interest (ROIs) were obtained after setting significant α level to 0.005 and the minimum number of neighboring voxels to 30. Mean current density values in the ROIs were exported for further statistical analyses using 2 Cue x 2 Polarity repeated measures ANOVA.

3.3.3. Results

3.3.3.1. Behavioral results

3.3.3.1.1. Go/NoGo task

Go-trial reaction times in milliseconds were analyzed after eliminating incorrect responses and outliers with scores 3 SDs above the individual mean (about 1%). Sentence Polarity did not produce significant effect on Go-trial reaction times

(affirmative: M= 326, SD = 42; negative: M = 331, SD = 51; *t*(23) = -.775, p = .446, Cohen's d = -.158). There was no main effect of Cue on error rates (F(1, 23) = 2.086, p = .162, η^2_p = .083), meaning that commission error rates in NoGo condition were comparable to omission error rates in Go condition. Also, Polarity conditions did not differ either on commission errors in NoGo trials (affirmative: M = 4.2%, SD = 4.9%; negative: M = 4.9%; SD = 6.0%; *t*(23) = -.504, p = .619, Cohen's d = -.103) or on omission errors in Go trials (affirmative: M = 2.8%, SD = 3.1%; negative: M = 3.3%; SD = 3.1%; *t*(23) = -.942, p = .356, Cohen's d = -.192).

3.3.3.1.2. Probe verification task

Average reaction times were obtained after removing response errors and times exceeding 3 SDs of the participants mean (about 1.7%). Both Cue (F(1, 23) = 9.736, p = .005, η^2_p = .297) and Polarity (F(1, 23) = 4.615, p = .042, η^2_p = .167) produced significant effects on reaction times, though no Cue x Polarity interaction was found (F(1, 23) < 1, p = .755). Responses were faster in Go than in NoGo and in affirmative than in negative condition. Concerning the error rates, the repeated measures ANOVA yielded no significant effects of Cue (F(1, 23) < 1, p = .491), Polarity (F(1, 23) < 1, p = .999) or their interaction (F(1, 23) < 1, p = .343). Means and SDs are shown in **Table 2**.

Table 2. **Performance in the probe verification task. Mean reaction times in milliseconds and percentage of errors as a function of Cue (Go/NoGo) and Polarity (affirmative/negative). SDs are shown in parentheses.**

	Reaction times (ms)			Error rates (%)		
	AFF	**NEG**	**NEG-AFF**	**AFF**	**NEG**	**NEG-AFF**
Go	648 (114)	661 (119)	13	0.8 (1.8)	1.4 (2.6)	0.6
NoGo	675 (117)	691 (120)	16	1.7 (2.8)	1.1 (1.9)	-0.6
NoGo-Go	27	30		0.9	-0.3	

3.3.3.1.3. Coherence judgment task

Incorrect responses and reaction times exceeding 3 SDs of the individual mean (about 0.5%) were removed before the performance data were submitted to statistical comparisons. Repeated measures ANOVA of reaction times did not yield any significant effects ($F(1, 23) < 3$, $p > .1$). However, there was a main effect of Polarity on error rates ($F(1, 23) = 34.73$, $p < .001$, $\eta^2_p = .602$). Specifically, negative trials produced more errors than affirmative trials. Means and SDs are shown in **Table 3**.

Table 3. **Performance in the coherence judgment task. Mean reaction times in milliseconds and percentage of errors as a function of Cue (Go/NoGo) and Polarity (affirmative/negative). SDs are shown in parentheses. The coherence judgment task was included in 40% of the experimental trials (12 for Go-affirmative, 12 for Go-negative, 12 for NoGo-affirmative, and 12 for NoGo-negative trials).**

	Reaction times (ms)			**Error rates (%)**		
	AFF	**NEG**	**NEG-AFF**	**AFF**	**NEG**	**NEG-AFF**
Go	2370 (501)	2526 (560)	156	11.8 (9.8)	30.9 (17.6)	19.1
NoGo	2396 (491)	2396 (583)	0	14.6 (10.2)	28.1 (14.7)	13.5
NoGo-Go	26	-130		2.8	-2.8	

3.3.3.2. ERP results

As expected, the waveforms and topographies observed in the current study for the Go vs. NoGo comparisons correspond to the well-known N2 and P3 effects (**Figure 2**), which are typical signatures of inhibition-related processes (Cheng et al., 2019; Jonkman et al., 2003; Maguire et al., 2009). Specifically, NoGo trials elicited larger fronto-central amplitudes of N2 (210-258 ms) and P3 (300-450 ms) than Go trials.

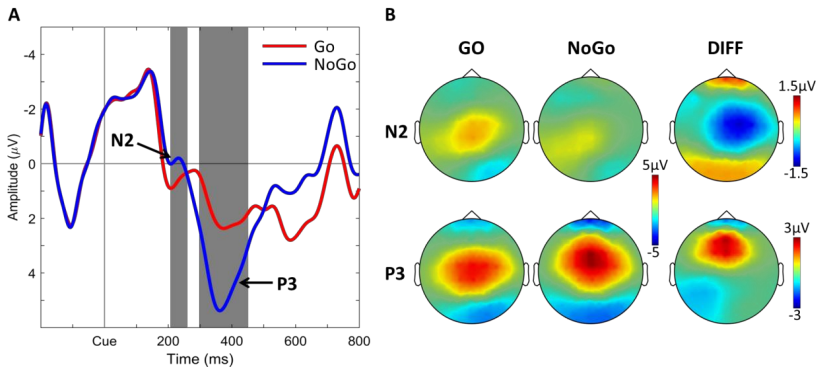

Figure 2. Event-related potentials of the Go/NoGo task. (A) Average waveforms of N2 (210-258 ms) and P3 (300-450 ms) components in five representative electrodes (FZ, FC1, FCZ, FC2, CZ) of the fronto-central brain region. (B) Topographical distributions of the ERP activities in the N2 and P3 time windows. The NoGo minus Go difference topographies are presented on the right-utmost column.

The average waveform amplitudes in these fronto-central electrodes (FZ, FC1, FCZ, FC2, CZ) for the identified N2 and P3 time windows were used as input for repeated measures ANOVA, with Cue x Polarity as within subject factors. For the N2 component (time window: 210-258 ms), there was only a main effect of Cue ($F(1, 23) = 8.536$, $p = .008$, $\eta^2_p = .271$), with the waveforms for NoGo trials showing more negative deflections than the Go trials. No main effect of Polarity or interaction was found in this time window ($F(1, 23) < .1$, $p > .7$). For the P3 component (time window: 300-450 ms), the ANOVA obtained both main effects of Cue and Polarity, with more

positive waveforms for NoGo than for Go trials ($F(1, 23) = 65.471$, $p < .001$, $\eta^2_p = .74$) and for negative than for affirmative trials ($F(1, 23) = 4.411$, $p = .047$, $\eta^2_p = .161$). Importantly, there was also a significant Cue x Polarity interaction ($F(1, 23) = 6.528$, $p = .018$, $\eta^2_p = .221$). Negative trials elicited more positive waveforms than affirmative trials in NoGo condition ($t(23) = -4.617$, $p < .001$, Cohen's d = -0.943), whereas no such Polarity difference was found in Go condition ($t(23) = 0.211$, $p = .835$, Cohen's d = .043). Waveforms and topographies of the Cue x Polarity conditions are shown in **Figure 3**.

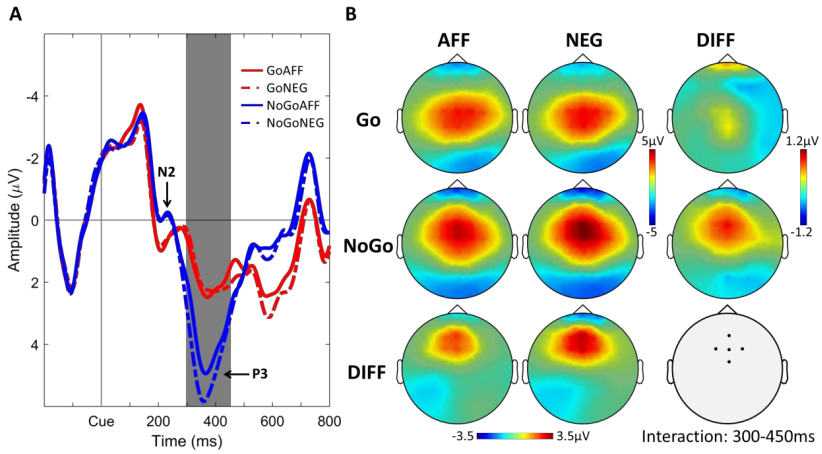

Figure 3. Event-related potentials of the Cue x Polarity interaction. (A) Average waveforms of the fronto-central electrodes (FZ, FC1, FCZ, FC2, CZ) in each of the Cue x Polarity conditions in the P3 time window (300-450 ms). (B) Topographical distributions of the ERP activities corresponding to each Cue x Polarity condition in the P3 time window. Differences between negative and affirmative trials in different Cue conditions (Go vs. NoGo) are shown on the right-utmost column; and differences between NoGo and Go trials in different Polarity conditions (affirmative vs. negative) are presented at the bottom line. The black dots correspond to the fronto-central electrodes showing significant Cue x Polarity interactions.

3.3.3.3. Source localization results

Source estimation analysis was conducted to better understand the neural processes underlying the Cue x Polarity interaction obtained in the P3 component. To this end, source files of affirmative and negative trials in NoGo condition were compared statistically using paired permutation *t*-test. As shown in **Figure 4A**, the brain sources that showed significant difference ($p < .005$) were located at the right supplementary/pre-supplementary motor area (SMA/pre-SMA) and bilateral mid-cingulate cortex (MCC). Two ROIs were created accordingly: one for the right SMA/pre-SMA and the other for the bilateral MCC. The average current densities in different Cue x Polarity conditions at each ROI were statistically compared using repeated measures ANOVAs. As shown in **Figure 4B**, the directions of the differences were the same for the right SMA/pre-SMA and the bilateral MCC. Specifically, there were both main effects of Cue (SMA/pre-SMA: $F(1, 23) = 5.434$, $p = .029$, $\eta^2_p = .191$; MCC: $F(1, 23) = 28.269$, $p < .001$, $\eta^2_p = .551$) and Polarity (SMA/pre-SMA: $F(1, 23) = 7.468$, $p = .012$, $\eta^2_p = .245$; MCC: $F(1, 23) = 14.412$, $p < .001$, $\eta^2_p = .385$). Critically, the Cue x Polarity interaction was also significant (SMA/pre-SMA: $F(1, 23) = 10.175$, $p = .004$, $\eta^2_p = .307$; MCC: $F(1,23) = 8.604$, $p = .007$, $\eta^2_p = .272$). Follow-up comparisons revealed that the current densities for NoGo-negative trials differed significantly from NoGo-affirmative trials (SMA/pre-SMA: $t(23) = 3.662$, $p = .001$, Cohen's $d = .748$; MCC: $t(23) = 5.726$, p

< .001, Cohen's d = 1.169), however, Polarity conditions did not differ for Go trials ($t(23) < 1$).

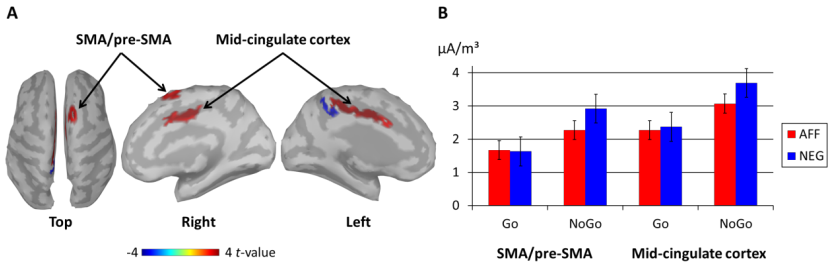

Figure 3. Source estimation corresponding to the Cue x Polarity interaction in the P3 time window (300-450 ms). (A) Brain localizations showing interactions: right SMA/pre-SMA and bilateral MCC. (B) Mean current densities of Cue x Polarity conditions in the ROIs.

3.3.4. Discussion

This study tested the generality of the RIN hypothesis, examining whether comprehension of existential negations also reuses neural resources of the inhibitory control mechanisms. Participants read both affirmative and negative existential sentences for subsequent probe verification and coherence judgment tasks, while performing an embedded Go/NoGo task. The results support the generality of the RIN hypothesis. Specifically, negative existential sentences induced larger P3 amplitude than affirmative existential sentences only in the inhibitory NoGo trials, and the

estimated brain sources for such differential modulations of negation were the inhibition-related SMA/pre-SMA and MCC.

EEG studies adopting Go/NoGo paradigms consistently reported two major ERP components that could be associated with inhibitory control processes. The first one is the N2 component, a more enhanced fronto-central negativity in NoGo compared to Go condition, peaking at approximately 200-300 ms after the Go/NoGo Cue onset (Bokura et al., 2001; Bruin & Wijers, 2002; Eimer, 1993; Zhang et al., 2007). The other one is the P3 component, a positive waveform showing larger amplitudes for NoGo relative to Go trials with fronto-central or parieto-central distributions, peaking at about the 300-500 ms post-Cue time window (Bokura et al., 2001; Kamarajan et al., 2005; Smith et al., 2008). While the N2 may reflect a non-motoric stage of inhibition or recognition of the need for inhibition (Smith et al., 2008), the P3 is considered to be more related to response inhibition and reflects a later stage of the inhibitory control processes (Bruin et al., 2001; Kamarajan et al., 2005; Nguyen et al., 2016; Smith et al., 2013; Zhang et al., 2007). In the current study, NoGo-negative trials elicited larger P3 than NoGo-affirmative trials, while no such disparity in waveform amplitudes was found between Go-negative and Go-affirmative trials. The selective modulation of P3 indicates that understanding negative existential sentences relies on the inhibitory control mechanisms, possibly competing for inhibitory resources at the late stage of response inhibition processes in NoGo trials, thus leading to enhanced P3 in NoGo-negative compared to NoGo-affirmative condition.

Previous studies employing similar embedded Go/NoGo paradigms reported interactions between negation and inhibition in early EEG signatures, like theta oscillations (Beltrán et al., 2019; de Vega et al., 2016) and N2 component (Liu, Wang, et al., 2020), which began at about 200 ms after the Go/NoGo Cue onset. However, the current study found the interaction between negation and inhibition in the P3 component, starting at about 300 ms after the Go/NoGo Cue onset. The reasons for the delayed appearance of the interaction could be multifold, but we may venture a possible explanation based on the different task demands between the current study and the previous ones. In the previous studies, only about one third of the trials were followed by a simple sentence recognition task. However, in the present study, all trials were immediately followed by a probe verification task, involving an additional working memory demand. Moreover, 40% of the experimental trials contained a coherence judgment task for which the participants needed to judge whether a new sentence was a sensible continuation of the preceding sentence. These tasks could largely increase the cognitive load during sentence comprehension and the Go/NoGo task, thus postponing the interaction as reflected in P3 rather than N2/theta power. The increased task demands may also account for the directions of the ERP waveform differences between negative and affirmative NoGo trials. Previous studies reported reduced N2/theta power in NoGo-negative compared to NoGo-affirmative condition, possibly indicating a facilitatory effect of negation on response inhibition due to inhibitory priming (Beltrán et al., 2019; de Vega et al., 2016; Liu, Wang, et al., 2020). However, in the current study, the cognitive load induced by the additional tasks

(probe verification and coherence judgment) could delay the peak of inhibitory control demands for negation until the late stage of response inhibition, leading to the more enhanced P3 for NoGo-negative relative to NoGo-affirmative trials. The interaction between Cue and Polarity in P3 amplitudes obtained here supports the RIN hypothesis, and was unlikely caused by purely linguistic factors, since affirmative and negative existential sentences only differed in a single monosyllabic word: the negative Polarity marker (no) versus the temporal adverb (ya), and the assignment of sentences to each experimental condition as a combination of Go/NoGo Cue and Sentence Polarity was counterbalanced, eliminating possible influence of any lexical variable.

The source localizations of the P3 effect in the right SMA/pre-SMA and bilateral MCC also support the RIN hypothesis; that is, the comprehension of negative existential sentences reuses significant networks of the inhibitory control mechanisms. Evidence for the involvement of SMA/pre-SMA in inhibition-related processes comes from neuroimaging (Huster et al., 2011; Nakata et al., 2008; Sharp et al., 2010), neuropsychology (Sumner et al., 2007), brain stimulation (Obeso et al., 2013) and source localization (Albert et al., 2013) studies. The functional role of SMA/pre-SMA could be critical in inhibitory processes, and it has been suggested that the rIFG and SMA/pre-SMA might coordinate inhibition through direct white-matter connections, as well as via the sub-thalamic nucleus of the basal ganglia (Chambers et al., 2009). The MCC is also involved in motor control and response inhibition processes, which

is a major neural generator of the N2 and P3 components in inhibitory tasks (Hoffstaedter et al., 2014; Huster et al., 2010). In the current study, negative sentences compared to affirmative ones increased activations in the right SMA/pre-SMA and bilateral MCC in NoGo trials, indicating that negation consumes more inhibitory resources. This pattern is compatible with the ERP results, jointly supporting the RIN hypothesis that comprehension of existential negations reuses the inhibitory control mechanisms, resulting in enhanced NoGo-P3 and increased activations in the inhibition-related SMA/pre-SMA and MCC.

Although the current experimental paradigm may seem very demanding, due to the combination of Go/NoGo task with probe verification and coherence judgment tasks, the participants were capable of performing the tasks efficiently. Accuracies were high for both the Go/NoGo task (> 95%) and the probe verification task (> 98%). Even for the coherence judgment task, which was more challenging, the participants responded correctly in almost 80% of the trials. Furthermore, performance was significantly better for affirmative than for negative trials in both the probe verification and the coherence judgment tasks. In line with previous behavioral studies, the longer response latencies for the negated objects in the probe verification task indicate that negation reduces the activation of the negated concepts (Kaup, 2001; Kaup & Zwaan, 2003; MacDonald & Just, 1989). On the other hand, the higher error rates for negative sentences in the coherence judgment task suggest that negation

hinders memory retrieval of the negative statements (MacDonald & Just, 1989; Margolin & Abrams, 2009; Mayo, Schul & Rosenthal, 2014).

In sum, this study confirms the generality of the RIN hypothesis, extending its applicability beyond action language and imperative sentences to purely declarative existential sentences. Namely, comprehension of negation in existential sentence context also reuses the inhibitory control mechanisms. Despite its important theoretical implications, our study must be complemented by future researches to clarify additional questions. For instance, to uncover whether the interactive effects between existential negation and response inhibition are unidirectional or reciprocal. Given the temporal structure of the trials, this study only revealed a unidirectional effect of existential negation on response inhibition, but it would be worth testing the reverse effect, that is, whether presetting an inhibition state modulates the processing of existential negation, as was the case of action-related negation (Liu, Gu, et al., 2020). Another research avenue could be to verify the involvement of inhibition-related areas (e.g., SMA/preSMA, rIFG, ACC, MCC) in negation. Finally, to better understand the causal role of the inhibitory neural networks (e.g., SMA/pre-SMA) in negation, it would be useful to apply non-invasive brain stimulation (i.e., rTMS) over the inhibition-related brain region(s) and analyze how it impacts the comprehension of negation.

3.3.5. Conclusion

This study assessed the generality of the RIN hypothesis in existential sentences. The applicability of the RIN hypothesis to existential negations was confirmed by both ERP and source localization results. Specifically, negation in existential sentences enhanced the P3 component associated with inhibition and elicited stronger activations in the inhibition-related SMA/pre-SMA and MCC only in NoGo trials, suggesting that negative existential sentences share neural mechanisms with inhibitory control processes, thus extending the RIN hypothesis to the domain of existential negation.

Acknowledgement

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General discussion

The current doctoral dissertation aims to explore the neurophysiology of linguistic negation by investigating the functional role of the inhibitory control neural networks during negation processing. Through three experiments, the dissertation managed to demonstrate the robustness and generalizability of the Reusing Inhibition for Negation (RIN) hypothesis: confirming some of its predictions with different languages (Spanish and Mandarin), showing the mutual influence of understanding sentential negation and response inhibition tasks (negation preceding or following inhibition) and expanding the scope of domains to which the RIN hypothesis applies (action-related imperatives and existential sentences).

Experiment 1 was designed in accordance with Objective 1 of the dissertation, in which Mandarin was chosen to test the generalizability of the RIN hypothesis due to its distinctive linguistic features and neurophysiological underpinnings. Most relevant to the inhibition hypothesis of negation is that Mandarin reading shares neural resources with inhibitory control processes in the LMFG and rIFG (Chambers et al., 2009; Kuo et al., 2001; Nakata et al., 2008; Tan, Liu, et al., 2001; Wu et al., 2012), which opens the possibility that the involvement of inhibitory control mechanisms in negation might be dampened in Mandarin due to competition for neural resources with the reading of logographic characters. Experiment 1 adopted the dual-task paradigm employed in previous studies with Spanish materials and participants (Beltrán et al., 2019; de Vega et al., 2016), namely, a Go/NoGo task embedded in a

reading task of both affirmative and negative Mandarin sentences. It was found that the N2 amplitude of NoGo trials was reduced in the context of negation compared to affirmation, indicating that comprehension of negation shares neural resources with the inhibitory control processes and facilitates response inhibition. Such modulation of negation on inhibition-related N2 and its likely source in the inhibition-related rIPL (Garavan et al., 1999; Nakata et al., 2008; Rubia et al., 2001) supports the RIN hypothesis and extends its range of application from alphabetic Indo-European languages to logographic Mandarin.

Objective 2 was examined in Experiment 2, in which the sequence of inhibition and negation was reversed compared to previous studies (Beltrán et al., 2019; Beltrán et al., 2018; de Vega et al., 2016) to investigate the bi-directionality of the impacts of inhibition and negation on each other. Whereas in the previous studies the Go/NoGo task followed affirmative or negative language, here the Go/NoGo task preceded the comprehension of both affirmative and negative action-related imperative sentences to test whether a preset inhibitory state modulates the neural processing of linguistic negation. The sustained modulatory effect in ERPs appeared shortly after the negation marker onset only in inhibitory NoGo trials, indicating that the pre-established inhibitory state modified the neural processes of negation. The overlap of topographical distributions between the ERP interaction effect and the late effect of the Go/NoGo task suggests that negation probably prolonged the preset inhibitory state. This interpretation was further supported by the finding that negation consumed

more inhibitory resources in the LMFG and rIFG, which are regions associated with inhibitory processes, especially the latter which plays a directive role (Chambers et al., 2009; Nakata et al., 2008; Swann et al., 2012).

Finally, to accomplish Objective 3, Experiment 3 tested the RIN hypothesis in the context of existential sentences to determine whether the hypothetical role of the inhibitory control neural networks during negation comprehension was domain-general or constrained to action language and imperative contents. Negative imperatives often denote commands to restrain or stop action performance, which share similar operational functions with the NoGo cues in a Go/NoGo task or the Stop signals in a Stop-Signal task. The sharing of functional denotations between negative imperatives and inhibition cues might partially account for the modulatory effect of negation on response inhibition obtained by previous studies (Beltrán et al., 2019; Beltrán et al., 2018; de Vega et al., 2016). By contrast, existential sentences are purely declarative and do not refer to any explicit actions or imperative commands. This makes existential negation an interesting case to test the generality of the RIN hypothesis, avoiding any functional similarity between the negation marker and the NoGo cue. In spite of this, the results of Experiment 3 showed that negation in existential sentences also modified response inhibition in the embedded Go/NoGo task in that it elicited larger P3 amplitude than affirmatives in the inhibitory NoGo trials, indicating possibly that negation consumes inhibitory resources and interferes with ensuing inhibitory control processes. Complementing previous findings, the

modulatory effect of existential negation on response inhibition reinforces the RIN hypothesis and suggests that the recruitment of inhibitory control mechanisms for negation is general-purpose rather than restrictive to action language and imperatives. Unlike in previous studies, here the interactive effect between negation and inhibition was delayed till the P3 component rather than reflected in the N2 component or theta oscillations (Beltrán et al., 2019; de Vega et al., 2016; Liu, Wang, et al., 2020). A possible reason for the delayed interaction could be the increased task difficulty in sentence comprehension posed by the additional probe verification and coherence judgment tasks. This increase in task demand and cognitive load might also explain the different modulations of negation on inhibition, showing facilitation in previous studies but interference in the current experiment.

The current findings not only confirm the predictions of the RIN hypothesis, but also provide important complementary information to the two-step account of negation processing (Kaup & Zwaan, 2003). According to this two-step model, the representation of the negated concept or situation is activated in the first step as if the negation marker were absent, thus producing a similar representation to the corresponding affirmation. The integration of the negation marker into meaning representation takes place afterwards as a second step, leading to suppression or deactivation of the previously activated representation and finally the replacement of it by the actual state of affairs. Yet, an important question is left open by the two-step model, namely, how is the prior representation suppressed in the second step? In other

words, what neural machinery is responsible for the dynamic processes of meaning representation involved in negation comprehension? The current doctoral dissertation offers a likely answer to the above question: the neural circuits of inhibitory control processes are recruited to suppress the initially activated representation during the comprehension of negative statements.

The results found in the current research also shed additional light on the embodiment theories which propose that language comprehension involves sensorimotor simulations in a content-specific manner, in other words, understanding the contents of linguistic utterances induces resonance in specific sensorimotor networks to simulate the referred concepts (Barsalou, 2008; de Vega et al., 2014; Fischer & Zwaan, 2008; Moody & Gennari, 2010; Zwaan, 2016). Yet, negation - an abstract syntactic operator - poses a challenge on this embodied approach to language, since sensorimotor simulation of the negated concepts seems optional and dispensable. The "disembodiment" effect of negation gains support from neuroimaging (Tettamanti et al., 2008; Tomasino et al., 2010), brain stimulation (Liuzza et al., 2011), electromyography (Foroni & Semin, 2013) and fine-grained kinematic studies (Aravena et al., 2012; Bartoli et al., 2013), consistently showing that negation diminishes activations in the motor cortices or systems that are associated with affirmations. The three experiments in the current doctoral dissertation investigated negation from a new perspective, focusing on the neural processes of negation itself rather than negation-induced consequences. The results yielded the possibility that

comprehension of negation is also embodied, as it might be grounded on the high-order inhibitory mechanisms for action control.

The current research has important theoretical implications, yet it opens new questions, which require further research, concerning the functional role of the inhibitory control neural networks in the processing of linguistic negation. First, although the current research consolidates the RIN hypothesis and generalizes it beyond action-related and imperative sentences to purely declarative existential sentences, there are still other untested pragmatic and semantic domains of negation. Additional proofs from more diverse dimensions of negation are needed to further examine the RIN hypothesis and extend its scope of applicability. Second, according to the current research and also previous studies testing the RIN hypothesis (Beltrán et al., 2019; Beltrán et al., 2018; de Vega et al., 2016), the processing of negation could either facilitate or interfere with subsequent inhibitory control processes, which is likely to be modulated by task difficulty. Due to the lack of sufficient empirical evidence, further studies adopting tasks with fine-scaled semantic and inhibitory demands are necessary to better explain the different directions of the modulations of negation on inhibitory control processes. Third, the reuse of inhibitory resources for negation as proposed by the RIN hypothesis was motivated by the rationale that both negation and inhibitory control consist in suppressing previously activated representations (de Vega et al., 2016). However, providing proper contextual information or background knowledge, the difficulties associated with negation would

diminish (Nieuwland & Kuperberg, 2008) and, contrary to the two-step model predictions, attentions would be directly applied to the actual state of affair rather than the negated contents (Orenes et al., 2014). The RIN hypothesis needs to be examined against the backdrop where pragmatic factors render the suppression of meaning representations irrelevant or unnecessary. Fourth, most of the extant studies tested and confirmed the RIN hypothesis by examining the interactions between negation and inhibition reflected in event-related potentials (ERPs) and time-frequency representations (TFRs). Though EEG technique has high temporal resolution, it is unable to provide detailed neuroanatomical information about relevant neural activities. Therefore, neuroimaging studies are needed to identify the specific brain regions shared by inhibitory control processes and negation comprehension and also the brain regions that are differentially modulated when negation precedes inhibition or vice versa, in order to unveil not only "whether" but also "where" negation reuses the inhibitory control mechanisms.

Conclusions

In summary, the research reported in this doctoral dissertation confirms that the primitive inhibitory control neural mechanisms of human beings are reused for the functional purpose of understanding linguistic negation.

1. Sentential negation in Mandarin modulates the inhibition-related N2 component of the ERPs in inhibitory context (NoGo trials) with an estimated source in the inhibition-related rIPL, confirming a negation-to-inhibition priming effect.

2. The recycling of inhibitory neural resources for negation applies to both alphabetic Indo-European languages and logographic Mandarin, which differ significantly in their neural demands, thus confirming the cross-linguistic generality of the RIN hypothesis.

3. The presetting of an inhibitory state by a NoGo cue before the sentence modulates the ERP waveform of sentential negation, suggesting that negation prolonged the inhibitory state. That is, there is an inhibition-to-negation priming effect.

4. The above inhibition-to-negation priming complements the negation-to-inhibition priming reported in the literature and in this dissertation, allowing the establishment of a bi-directional influence between the two processes which reinforces the RIN hypothesis.

5. Negation in existential sentences also modulates the inhibitory control processes required by a Go/NoGo task as is the case with action-related imperative sentences,

which is reflected in the inhibition-related P3 component of the ERPs with the likely generators of such effect localized in the inhibition-related SMA/pre-SMA and mid-cingulate cortex.

6. The applicability of the RIN hypothesis is not constrained to action language or imperative sentences but also extends to purely declarative existential contents, indicating that the reuse of inhibitory control mechanisms for negation comprehension is domain-general rather than content-specific.

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Appendices

Appendix 1

Materials for Experiment 1

Experimental sentences in Chinese and their English translations	
Affirmative sentences	**Identical recognition sentences**
现在请掰面包 Now please split the bread	现在请掰面包 Now please split the bread
现在请擦桌子 Now please wipe the table	现在请擦桌子 Now please wipe the table
现在请插耳机 Now please plug in the earphones	现在请插耳机 Now please plug in the earphones
现在请炒白菜 Now please stir-fry the Chinese cabbage	现在请炒白菜 Now please stir-fry the Chinese cabbage
现在请递话筒 Now please pass the microphone	现在请递话筒 Now please pass the microphone
现在请翻教材 Now please flip the textbook	现在请翻教材 Now please flip the textbook
现在请剪胶带 Now please snip the tape	现在请剪胶带 Now please snip the tape
现在请搅咖啡 Now please stir the coffee	现在请搅咖啡 Now please stir the coffee
现在请举牌子 Now please raise the sign	现在请举牌子 Now please raise the sign
现在请挠胳膊 Now please scratch the arm	现在请挠胳膊 Now please scratch the arm
现在请铺床单 Now please spread the bedsheet	现在请铺床单 Now please spread the bedsheet
现在请切蛋糕 Now please cut the cake	现在请切蛋糕 Now please cut the cake
现在请揉肚子 Now please rub the belly	现在请揉肚子 Now please rub the belly

现在请扫灰尘 Now please sweep the dust	现在请扫灰尘 Now please sweep the dust
现在请刷盘子 Now please wash the plate	现在请刷盘子 Now please wash the plate
现在请撕包装 Now please tear the package	现在请撕包装 Now please tear the package
现在请捂嘴巴 Now please cover the mouth	现在请捂嘴巴 Now please cover the mouth
现在请摇跳绳 Now please swing the skipping rope	现在请摇跳绳 Now please swing the skipping rope
现在请掰面包 Now please split the bread	现在请掰面包 Now please split the bread
现在请举牌子 Now please raise the sign	现在请举牌子 Now please raise the sign
现在请扫灰尘 Now please sweep the dust	现在请扫灰尘 Now please sweep the dust
Affirmative sentences	**Polarity-modified recognition sentences**
现在请拌冷面 Now please mix the cold noodles	现在别拌冷面 Now don’t mix the cold noodles
现在请炒白菜 Now please stir-fry the Chinese cabbage	现在别炒白菜 Now don’t stir-fry the Chinese cabbage
现在请搅咖啡 Now please stir the coffee	现在别搅咖啡 Now don’t stir the coffee
现在请摇跳绳 Now please swing the skipping rope	现在别摇跳绳 Now don’t swing the skipping rope
现在请挠胳膊 Now please scratch the arm	现在别挠胳膊 Now don’t scratch the arm
现在请涂药水 Now please smear the lotion	现在别涂药水 Now don’t smear the lotion
现在请摇跳绳 Now please swing the skipping rope	现在别摇跳绳 Now don’t swing the skipping rope
Affirmative sentences	**Verb-modified recognition sentences**
现在请掰面包 Now please split the bread	现在请切面包 Now please cut the bread
现在请剥鸡蛋 Now please peel the egg	现在请炒鸡蛋 Now please stir-fry the egg
现在请举牌子 Now please raise the sign	现在请挂牌子 Now please hang the sign
现在请铺床单 Now please spread the bedsheet	现在请晾床单 Now please air the bedsheet
现在请扫灰尘	现在请擦灰尘

Now please sweep the dust	Now please wipe the dust
现在请握杯子 Now please hold the glass	现在请刷杯子 Now please wash the glass
现在请捂嘴巴 Now please cover the mouth	现在请擦嘴巴 Now please wipe the mouth
Affirmative sentences	**Noun-modified recognition sentences**
现在请擦桌子 Now please wipe the table	现在请擦地板 Now please wipe the floor
现在请摁开关 Now please press the button	现在请摁门铃 Now please press the doorbell
现在请翻教材 Now please flip the textbook	现在请翻相册 Now please flip the photo album
现在请拧瓶盖 Now please screw the lid	现在请拧螺丝 Now please screw the screw
现在请切蛋糕 Now please cut the cake	现在请切黄瓜 Now please cut the cucumber
现在请捂嘴巴 Now please cover the mouth	现在请捂鼻子 Now please cover the nose
现在请搅咖啡 Now please stir the coffee	现在请搅奶茶 Now please stir the milk tea
Affirmative sentences	**No recognition sentences**
现在请掰面包 Now please split the bread	
现在请拌冷面 Now please mix the cold noodles	
现在请剥鸡蛋 Now please peel the egg	
现在请擦桌子 Now please wipe the table	
现在请插耳机 Now please plug in the earphones	
现在请炒白菜 Now please stir-fry the Chinese cabbage	
现在请递话筒 Now please pass the microphone	
现在请摁开关 Now please press the button	
现在请翻教材 Now please flip the textbook	
现在请剪胶带 Now please snip the tape	

现在请搅咖啡 Now please stir the coffee	
现在请举牌子 Now please raise the sign	
现在请挠胳膊 Now please scratch the arm	
现在请拧瓶盖 Now please screw the lid	
现在请铺床单 Now please spread the bedsheet	
现在请切蛋糕 Now please cut the cake	
现在请揉肚子 Now please rub the belly	
现在请扫灰尘 Now please sweep the dust	
现在请刷盘子 Now please wash the plate	
现在请撕包装 Now please tear the package	
现在请涂药水 Now please smear the lotion	
现在请握杯子 Now please hold the glass	
现在请捂嘴巴 Now please cover the mouth	
现在请摇跳绳 Now please swing the skipping rope	
现在请掰面包 Now please split the bread	
现在请拌冷面 Now please mix the cold noodles	
现在请剥鸡蛋 Now please peel the egg	
现在请擦桌子 Now please wipe the table	
现在请插耳机 Now please plug in the earphones	
现在请炒白菜 Now please stir-fry the Chinese cabbage	
现在请递话筒 Now please pass the microphone	
现在请摁开关	

Now please press the button	
现在请翻教材 Now please flip the textbook	
现在请剪胶带 Now please snip the tape	
现在请搅咖啡 Now please stir the coffee	
现在请举牌子 Now please raise the sign	
现在请挠胳膊 Now please scratch the arm	
现在请拧瓶盖 Now please screw the lid	
现在请铺床单 Now please spread the bedsheet	
现在请切蛋糕 Now please cut the cake	
现在请揉肚子 Now please rub the belly	
现在请扫灰尘 Now please sweep the dust	
现在请刷盘子 Now please wash the plate	
现在请撕包装 Now please tear the package	
现在请涂药水 Now please smear the lotion	
现在请握杯子 Now please hold the glass	
现在请捂嘴巴 Now please cover the mouth	
现在请摇跳绳 Now please swing the skipping rope	
现在请掰面包 Now please split the bread	
现在请拌冷面 Now please mix the cold noodles	
现在请剥鸡蛋 Now please peel the egg	
现在请擦桌子 Now please wipe the table	
现在请插耳机 Now please plug in the earphones	

现在请炒白菜 Now please stir-fry the Chinese cabbage	
现在请递话筒 Now please pass the microphone	
现在请摁开关 Now please press the button	
现在请翻教材 Now please flip the textbook	
现在请剪胶带 Now please snip the tape	
现在请搅咖啡 Now please stir the coffee	
现在请举牌子 Now please raise the sign	
现在请挠胳膊 Now please scratch the arm	
现在请拧瓶盖 Now please screw the lid	
现在请铺床单 Now please spread the bedsheet	
现在请切蛋糕 Now please cut the cake	
现在请揉肚子 Now please rub the belly	
现在请扫灰尘 Now please sweep the dust	
现在请刷盘子 Now please wash the plate	
现在请撕包装 Now please tear the package	
现在请涂药水 Now please smear the lotion	
现在请握杯子 Now please hold the glass	
现在请捂嘴巴 Now please cover the mouth	
现在请摇跳绳 Now please swing the skipping rope	
现在请擦桌子 Now please wipe the table	
现在请炒白菜 Now please stir-fry the Chinese cabbage	
现在请翻教材	

Now please flip the textbook	
现在请挠胳膊 Now please scratch the arm	
现在请铺床单 Now please spread the bedsheet	
现在请切蛋糕 Now please cut the cake	
Negative sentences	**Identical recognition sentences**
现在别掰面包 Now don't split the bread	现在别掰面包 Now don't split the bread
现在别擦桌子 Now don't wipe the table	现在别擦桌子 Now don't wipe the table
现在别插耳机 Now don't plug in the earphones	现在别插耳机 Now don't plug in the earphones
现在别炒白菜 Now don't stir-fry the Chinese cabbage	现在别炒白菜 Now don't stir-fry the Chinese cabbage
现在别递话筒 Now don't pass the microphone	现在别递话筒 Now don't pass the microphone
现在别翻教材 Now don't flip the textbook	现在别翻教材 Now don't flip the textbook
现在别剪胶带 Now don't snip the tape	现在别剪胶带 Now don't snip the tape
现在别搅咖啡 Now don't stir the coffee	现在别搅咖啡 Now don't stir the coffee
现在别举牌子 Now don't raise the sign	现在别举牌子 Now don't raise the sign
现在别挠胳膊 Now don't scratch the arm	现在别挠胳膊 Now don't scratch the arm
现在别铺床单 Now don't spread the bedsheet	现在别铺床单 Now don't spread the bedsheet
现在别切蛋糕 Now don't cue the cake	现在别切蛋糕 Now don't cue the cake
现在别揉肚子 Now don't rub the belly	现在别揉肚子 Now don't rub the belly
现在别扫灰尘 Now don't sweep the dust	现在别扫灰尘 Now don't sweep the dust
现在别刷盘子 Now don't wash the plate	现在别刷盘子 Now don't wash the plate
现在别撕包装 Now don't tear the package	现在别撕包装 Now don't tear the package
现在别捂嘴巴 Now don't cover the mouth	现在别捂嘴巴 Now don't cover the mouth

现在别摇跳绳 Now don’t swing the skipping rope	现在别摇跳绳 Now don’t swing the skipping rope
现在别掰面包 Now don’t split the bread	现在别掰面包 Now don’t split the bread
现在别举牌子 Now don’t raise the sign	现在别举牌子 Now don’t raise the sign
现在别扫灰尘 Now don’t sweep the dust	现在别扫灰尘 Now don’t sweep the dust
Negative sentences	**Polarity-modified recognition sentences**
现在别拌冷面 Now don’t mix the cold noodles	现在请拌冷面 Now please mix the cold noodles
现在别炒白菜 Now don’t stir-fry the Chinese cabbage	现在请炒白菜 Now please stir-fry the Chinese cabbage
现在别搅咖啡 Now don’t stir the coffee	现在请搅咖啡 Now please stir the coffee
现在别摇跳绳 Now don’t swing the skipping rope	现在请摇跳绳 Now please swing the skipping rope
现在别挠胳膊 Now don’t scratch the arm	现在请挠胳膊 Now please scratch the arm
现在别涂药水 Now don’t smear the lotion	现在请涂药水 Now please smear the lotion
现在别摇跳绳 Now don’t swing the skipping rope	现在请摇跳绳 Now please swing the skipping rope
Negative sentences	**Verb-modified recognition sentences**
现在别掰面包 Now don’t split the bread	现在别切面包 Now don’t cut the bread
现在别剥鸡蛋 Now don’t peel the egg	现在别炒鸡蛋 Now don’t stir-fry the egg
现在别举牌子 Now don’t raise the sign	现在别挂牌子 Now don’t hang the sign
现在别铺床单 Now don’t spread the bedsheet	现在别晾床单 Now don’t air the bedsheet
现在别扫灰尘 Now don’t sweep the dust	现在别擦灰尘 Now don’t wipe the dust
现在别握杯子 Now don’t hold the glass	现在别刷杯子 Now don’t wash the glass
现在别捂嘴巴 Now don’t cover the mouth	现在别擦嘴巴 Now don’t wipe the mouth
Negative sentences	**Noun-modified recognition sentences**
现在别擦桌子	现在别擦地板

Now don't wipe the table	Now don't wipe the floor
现在别摁开关 Now don't press the button	现在别摁门铃 Now don't press the doorbell
现在别翻教材 Now don't flip the textbook	现在别翻相册 Now don't flip the photo album
现在别拧瓶盖 Now don't screw the lid	现在别拧螺丝 Now don't screw the screw
现在别切蛋糕 Now don't cut the cake	现在别切黄瓜 Now don't cut the cucumber
现在别捂嘴巴 Now don't cover the mouth	现在别捂鼻子 Now don't cover the nose
现在别搅咖啡 Now don't stir the coffee	现在别搅奶茶 Now don't stir the milk tea
Negative sentences	**No recognition sentences**
现在别掰面包 Now don't split the bread	
现在别拌冷面 Now don't mix the cold noodles	
现在别剥鸡蛋 Now don't peel the egg	
现在别擦桌子 Now don't wipe the table	
现在别插耳机 Now don't plug in the earphones	
现在别炒白菜 Now don't stir-fry the Chinese cabbage	
现在别递话筒 Now don't pass the microphone	
现在别摁开关 Now don't press the button	
现在别翻教材 Now don't flip the textbook	
现在别剪胶带 Now don't snip the tape	
现在别搅咖啡 Now don't stir the coffee	
现在别举牌子 Now don't raise the sign	
现在别挠胳膊 Now don't scratch the arm	
现在别拧瓶盖 Now don't screw the lid	

现在别铺床单 Now don’t spread the bedsheet	
现在别切蛋糕 Now don’t cue the cake	
现在别揉肚子 Now don’t rub the belly	
现在别扫灰尘 Now don’t sweep the dust	
现在别刷盘子 Now don’t wash the plate	
现在别撕包装 Now don’t tear the package	
现在别涂药水 Now don’t smear the lotion	
现在别握杯子 Now don’t hold the glass	
现在别捂嘴巴 Now don’t cover the mouth	
现在别摇跳绳 Now don’t swing the skipping rope	
现在别掰面包 Now don’t split the bread	
现在别拌冷面 Now don’t mix the cold noodles	
现在别剥鸡蛋 Now don’t peel the egg	
现在别擦桌子 Now don’t wipe the table	
现在别插耳机 Now don’t plug in the earphones	
现在别炒白菜 Now don’t stir-fry the Chinese cabbage	
现在别递话筒 Now don’t pass the microphone	
现在别摁开关 Now don’t press the button	
现在别翻教材 Now don’t flip the textbook	
现在别剪胶带 Now don’t snip the tape	
现在别搅咖啡 Now don’t stir the coffee	
现在别举牌子	

Now don’t raise the sign	
现在别挠胳膊 Now don’t scratch the arm	
现在别拧瓶盖 Now don’t screw the lid	
现在别铺床单 Now don’t spread the bedsheet	
现在别切蛋糕 Now don’t cue the cake	
现在别揉肚子 Now don’t rub the belly	
现在别扫灰尘 Now don’t sweep the dust	
现在别刷盘子 Now don’t wash the plate	
现在别撕包装 Now don’t tear the package	
现在别涂药水 Now don’t smear the lotion	
现在别握杯子 Now don’t hold the glass	
现在别捂嘴巴 Now don’t cover the mouth	
现在别摇跳绳 Now don’t swing the skipping rope	
现在别掰面包 Now don’t split the bread	
现在别拌冷面 Now don’t mix the cold noodles	
现在别剥鸡蛋 Now don’t peel the egg	
现在别擦桌子 Now don’t wipe the table	
现在别插耳机 Now don’t plug in the earphones	
现在别炒白菜 Now don’t stir-fry the Chinese cabbage	
现在别递话筒 Now don’t pass the microphone	
现在别摁开关 Now don’t press the button	
现在别翻教材 Now don’t flip the textbook	

现在别剪胶带 Now don’t snip the tape	
现在别搅咖啡 Now don’t stir the coffee	
现在别举牌子 Now don’t raise the sign	
现在别挠胳膊 Now don’t scratch the arm	
现在别拧瓶盖 Now don’t screw the lid	
现在别铺床单 Now don’t spread the bedsheet	
现在别切蛋糕 Now don’t cue the cake	
现在别揉肚子 Now don’t rub the belly	
现在别扫灰尘 Now don’t sweep the dust	
现在别刷盘子 Now don’t wash the plate	
现在别撕包装 Now don’t tear the package	
现在别涂药水 Now don’t smear the lotion	
现在别握杯子 Now don’t hold the glass	
现在别捂嘴巴 Now don’t cover the mouth	
现在别摇跳绳 Now don’t swing the skipping rope	
现在别擦桌子 Now don’t wipe the table	
现在别炒白菜 Now don’t stir-fry the Chinese cabbage	
现在别翻教材 Now don’t flip the textbook	
现在别挠胳膊 Now don’t scratch the arm	
现在别铺床单 Now don’t spread the bedsheet	
现在别切蛋糕 Now don’t cut the cake	

Filler sentences in Chinese and their English translations	
Affirmative sentences	**English translations**
稍后请敲键盘	Later please type the keyboard
稍后请贴对联	Later please paste the couplet
稍后请拎口袋	Later please carry the bag
稍后请挤牙膏	Later please squeeze the toothpaste
稍后请抬箱子	Later please lift the box
稍后请捶后背	Later please thump the back
稍后请梳头发	Later please comb the hair
稍后请扳闸门	Later please pull the switch
稍后请挥拍子	Later please wave the racket
稍后请刮彩票	Later please scratch the lottery ticket
稍后请抄歌词	Later please transcribe the lyrics
稍后请投硬币	Later please insert the coin
稍后请签名字	Later please sign the name
稍后请剁肉馅	Later please chop the stuffing
稍后请拽绳子	Later please drag the rope
稍后请洗衣服	Later please wash the clothes
Negative sentences	**English translations**
稍后别摆餐具	Later don’t set the tableware
稍后别投硬币	Later don’t insert the coin
稍后别刮彩票	Later don’t scratch the lottery ticket
稍后别扳闸门	Later don’t pull the switch
稍后别抬箱子	Later don’t lift the box
稍后别敲键盘	Later don’t tap the keyboard
稍后别拎口袋	Later don’t carry the bag
稍后别洗衣服	Later don’t wash the clothes

稍后别贴对联	Later don’t paste the couplet
稍后别挤牙膏	Later don’t squeeze the toothpaste
稍后别画圆圈	Later don’t draw a circle
稍后别摆餐具	Later don’t set the tableware
稍后别搬凳子	Later don’t move the chair
稍后别撬瓶塞	Later don’t pry the cork

Appendix 2

Materials for Experiment 2

Experimental sentences in Spanish and their English translations	
Affirmative sentences	**Identical recognition sentences**
Ahora sí abrirás la botella. (Now you will open the bottle.)	Ahora sí abrirás la botella. (Now you will open the bottle.)
Ahora sí abrirás el vino. (Now you will open the wine.)	Ahora sí abrirás el vino. (Now you will open the wine.)
Ahora sí abrirás el grifo. (Now you will open the tap.)	Ahora sí abrirás el grifo. (Now you will open the tap.)
Ahora sí amarrarás el globo. (Now you will tie the balloon.)	Ahora sí amarrarás el globo. (Now you will tie the balloon.)
Ahora sí amarrarás las sandalias. (Now you will tie the sandals.)	Ahora sí amarrarás las sandalias. (Now you will tie the sandals.)
Ahora sí apretarás el vendaje. (Now you will tighten the bandage.)	Ahora sí apretarás el vendaje. (Now you will tighten the bandage.)
Ahora sí cerrarás el tarro. (Now you will close the jar.)	Ahora sí cerrarás el tarro. (Now you will close the jar.)
Ahora sí cogerás el bolígrafo. (Now you will take the pen.)	Ahora sí cogerás el bolígrafo. (Now you will take the pen.)
Ahora sí cogerás las llaves. (Now you will take the keys.)	Ahora sí cogerás las llaves. (Now you will take the keys.)
Ahora sí cogerás el flotador. (Now you will take the float.)	Ahora sí cogerás el flotador. (Now you will take the float.)
Ahora sí colgarás el cuadro. (Now you will hang the painting.)	Ahora sí colgarás el cuadro. (Now you will hang the painting.)
Ahora sí copiarás la postal. (Now you will copy the postcard.)	Ahora sí copiarás la postal. (Now you will copy the postcard.)
Ahora sí copiarás la dirección. (Now you will copy the address.)	Ahora sí copiarás la dirección. (Now you will copy the address.)
Ahora sí copiarás una espiral. (Now you will copy a spiral.)	Ahora sí copiarás una espiral. (Now you will copy a spiral.)
Ahora sí cortarás la leña. (Now you will cut the wood.)	Ahora sí cortarás la leña. (Now you will cut the wood.)

Ahora sí cortarás la manzana. (Now you will cut the apple.)	Ahora sí cortarás la manzana. (Now you will cut the apple.)
Ahora sí cortarás el bizcochón. (Now you will cut the cake.)	Ahora sí cortarás el bizcochón. (Now you will cut the cake.)
Ahora sí cortarás el tomate. (Now you will cut the tomato.)	Ahora sí cortarás el tomate. (Now you will cut the tomato.)
Ahora sí cortarás el pastel. (Now you will cut the cake.)	Ahora sí cortarás el pastel. (Now you will cut the cake.)
Ahora sí doblarás el billete. (Now you will fold the ticket.)	Ahora sí doblarás el billete. (Now you will fold the ticket.)
Ahora sí doblarás el edredón. (Now you will fold the duvet.)	Ahora sí doblarás el edredón. (Now you will fold the duvet.)
Ahora sí doblarás los calcetines. (Now you will fold the socks.)	Ahora sí doblarás los calcetines. (Now you will fold the socks.)
Ahora sí encenderás la tele. (Now you will turn on the TV.)	Ahora sí encenderás la tele. (Now you will turn on the TV.)
Ahora sí encenderás la vela. (Now you will light the candle.)	Ahora sí encenderás la vela. (Now you will light the candle.)
Ahora sí fregarás la taza. (Now you will scrub the cup.)	Ahora sí fregarás la taza. (Now you will scrub the cup.)
Ahora sí guardarás el cargador. (Now you will collect the charger.)	Ahora sí guardarás el cargador. (Now you will collect the charger.)
Ahora sí guardarás el pergamino. (Now you will collect the parchment.)	Ahora sí guardarás el pergamino. (Now you will collect the parchment.)
Ahora sí guardarás el puzzle. (Now you will collect the puzzle.)	Ahora sí guardarás el puzzle. (Now you will collect the puzzle.)
Ahora sí guardarás el sándwich. (Now you will collect the sandwich.)	Ahora sí guardarás el sándwich. (Now you will collect the sandwich.)
Ahora sí levantarás la alfombra. (Now you will lift the carpet.)	Ahora sí levantarás la alfombra. (Now you will lift the carpet.)
Ahora sí levantarás el sofá. (Now you will lift the sofa.)	Ahora sí levantarás el sofá. (Now you will lift the sofa.)
Ahora sí levantarás el bastón. (Now you will lift the cane.)	Ahora sí levantarás el bastón. (Now you will lift the cane.)
Ahora sí limpiarás el mueble. (Now you will clean the furniture.)	Ahora sí limpiarás el mueble. (Now you will clean the furniture.)
Ahora sí moverás la ficha. (Now you will move the card.)	Ahora sí moverás la ficha. (Now you will move the card.)
Ahora sí moverás la bicicleta. (Now you will move the bike.)	Ahora sí moverás la bicicleta. (Now you will move the bike.)
Ahora sí moverás la pancarta. (Now you will move the banner.)	Ahora sí moverás la pancarta. (Now you will move the banner.)
Ahora sí moverás la mano.	Ahora sí moverás la mano.

(Now you will move your hand.)	(Now you will move your hand.)
Ahora sí plancharás el pañuelo. (Now you will iron the handkerchief.)	Ahora sí plancharás el pañuelo. (Now you will iron the handkerchief.)
Ahora sí plancharás la blusa. (Now you will iron the blouse.)	Ahora sí plancharás la blusa. (Now you will iron the blouse.)
Ahora sí plancharás el pantalón. (Now you will iron the pants.)	Ahora sí plancharás el pantalón. (Now you will iron the pants.)
Ahora sí plancharás las servilletas. (Now you will iron the napkins.)	Ahora sí plancharás las servilletas. (Now you will iron the napkins.)
Ahora sí regarás las flores. (Now you will water the flowers.)	Ahora sí regarás las flores. (Now you will water the flowers.)
Ahora sí tirarás los dados. (Now you will throw the dice.)	Ahora sí tirarás los dados. (Now you will throw the dice.)
Ahora sí tirarás la canica. (Now you will throw the marble.)	Ahora sí tirarás la canica. (Now you will throw the marble.)
Ahora sí tirarás una piedra. (Now you will throw a stone.)	Ahora sí tirarás una piedra. (Now you will throw a stone.)
Ahora sí tocarás las castañuelas. (Now you will play the castanets.)	Ahora sí tocarás las castañuelas. (Now you will play the castanets.)
Ahora sí tocarás la guitarra. (Now you will play the guitar.)	Ahora sí tocarás la guitarra. (Now you will play the guitar.)
Ahora sí tocarás el violín. (Now you will play the violin.)	Ahora sí tocarás el violín. (Now you will play the violin.)
Affirmative sentences	**Polarity-modified recognition sentences**
Ahora sí abrirás la ventana. (Now you will open the window.)	Ahora no abrirás la ventana. (Now you will not open the window.)
Ahora sí abrirás la lata. (Now you will open the can.)	Ahora no abrirás la lata. (Now you will not open the can.)
Ahora sí amarrarás el gato. (Now you will tie the cat.)	Ahora no amarrarás el gato. (Now you will not tie the cat.)
Ahora sí apretarás la tecla. (Now you will press the key.)	Ahora no apretarás la tecla. (Now you will not press the key.)
Ahora sí cerrarás la guantera. (Now you will close the glove compartment.)	Ahora no cerrarás la guantera. (Now you will not close the glove compartment.)
Ahora sí cogerás las tijeras. (Now you will take the scissors.)	Ahora no cogerás las tijeras. (Now you will not take the scissors.)
Ahora sí copiarás el dibujo. (Now you will copy the drawing.)	Ahora no copiarás el dibujo. (Now you will not copy the drawing.)
Ahora sí cortarás el queso. (Now you will cut the cheese.)	Ahora no cortarás el queso. (Now you will not cut the cheese.)
Ahora sí encenderás la luz.	Ahora no encenderás la luz.

(Now you will turn on the light.)	(Now you will not turn on the light.)
Ahora sí encenderás el ventilador. (Now you will turn on the fan.)	Ahora no encenderás el ventilador. (Now you will not turn on the fan.)
Ahora sí levantarás el lápiz. (Now you will lift the pencil.)	Ahora no levantarás el lápiz. (Now you will not lift the pencil.)
Ahora sí moverás la bandera. (Now you will move the flag.)	Ahora no moverás la bandera. (Now you will not move the flag.)
Ahora sí pelarás las castañas. (Now you will peel the chestnuts.)	Ahora no pelarás las castañas. (Now you will not peel the chestnuts.)
Ahora sí pelarás la mandarina. (Now you will peel the tangerine.)	Ahora no pelarás la mandarina. (Now you will not peel the tangerine.)
Ahora sí regarás el césped. (Now you will water the lawn.)	Ahora no regarás el césped. (Now you will not water the lawn.)
Ahora sí servirás el flan. (Now you will serve the flan.)	Ahora no servirás el flan. (Now you will not serve the flan.)
Ahora sí servirás la sidra. (Now you will serve the cider.)	Ahora no servirás la sidra. (Now you will not serve the cider.)
Ahora sí tirarás la basura. (Now you will throw the garbage.)	Ahora no tirarás la basura. (Now you will not throw the garbage.)
Affirmative sentences	**Verb-modified recognition sentences**
Ahora sí abrirás el equipaje. (Now you will open the luggage.)	Ahora sí perderás el equipaje. (Now you will lose the luggage.)
Ahora sí apretarás la plastilina. (Now you will pull the plasticine.)	Ahora sí comprarás la plastilina. (Now you will buy the plasticine.)
Ahora sí apretarás el tornillo. (Now you will tighten the screw.)	Ahora sí esconderás el tornillo. (Now you will hide the screw.)
Ahora sí cogerás las uvas. (Now you will take the grapes.)	Ahora sí pisarás las uvas. (Now you will step on the grapes.)
Ahora sí colgarás la percha. (Now you will hang the hanger.)	Ahora sí pintarás la percha. (Now you will paint the hanger.)
Ahora sí copiarás el informe. (Now you will copy the report.)	Ahora sí enviarás el informe. (Now you will send the report.)
Ahora sí copiarás el email. (Now you will copy the email.)	Ahora sí borrarás el email. (Now you will delete the email.)
Ahora sí cortarás el pan. (Now you will cut the bread.)	Ahora sí amasarás el pan. (Now you will knead the bread.)
Ahora sí encenderás el ordenador. (Now you will turn on the computer.)	Ahora sí alquilarás el ordenador. (Now you will rent the computer.)
Ahora sí fregarás la vajilla. (Now you will scrub the dishes.)	Ahora sí romperás la vajilla. (Now you will break the dishes.)
Ahora sí fregarás el patio. (Now you will scrub the patio.)	Ahora sí techarás el patio. (Now you will roof the patio.)

Ahora sí guardarás el anillo. (Now you will collect the ring.)	Ahora sí devolverás el anillo. (Now you will return the ring.)
Ahora sí guardarás la tarjeta. (Now you will collect the card.)	Ahora sí solicitarás la tarjeta. (Now you will request the card.)
Ahora sí moverás la manivela. (Now you will move the crank.)	Ahora sí fabricarás la manivela. (Now you will make the crank.)
Affirmative sentences	**Noun-modified recognition sentences**
Ahora sí amarrarás el cinturón. (Now you will tie the belt.)	Ahora sí amarrarás el cable. (Now you will tie the cable.)
Ahora sí amarrarás la bolsa. (Now you will tie the bag.)	Ahora sí amarrarás la correa. (Now you will tie the strap.)
Ahora sí cerrarás la cancela. (Now you will close the gate.)	Ahora sí cerrarás la habitación. (Now you will close the room.)
Ahora sí cogerás un clínex. (Now you will take a tissue.)	Ahora sí cogerás un avión. (Now you will catch a plane.)
Ahora sí colgarás el póster. (Now you will hang the poster.)	Ahora sí colgarás el hábito. (Now you will give up the habit.)
Ahora sí copiarás la frase. (Now you will copy the phrase.)	Ahora sí copiarás la carta. (Now you will copy the letter.)
Ahora sí cortarás el filete. (Now you will cut the steak.)	Ahora sí cortarás el calabacín. (Now you will cut the zucchini.)
Ahora sí limpiarás la baranda. (Now you will clean the railing.)	Ahora sí limpiarás la bañera. (Now you will clean the bathtub.)
Ahora sí pelarás el aguacate. (Now you will peel the avocado.)	Ahora sí pelarás el limón. (Now you will peel the lemon.)
Ahora sí pelarás los ajos. (Now you will peel the garlic.)	Ahora sí pelarás los melones. (Now you will peel the melons.)
Ahora sí plancharás la camisa. (Now you will iron the shirt.)	Ahora sí plancharás la americana. (Now you will iron the jacket.)
Ahora sí regarás la enredadera. (Now you will water the vine.)	Ahora sí regarás las plataneras. (Now you will water the banana trees.)
Ahora sí servirás el zumo. (Now you will serve the juice.)	Ahora sí servirás el gofio. (Now you will serve the gofio.)
Ahora sí tirarás el balón. (Now you will throw the ball.)	Ahora sí tirarás el boleto. (Now you will throw the ticket.)
Ahora sí tirarás el dardo. (Now you will throw the dart.)	Ahora sí tirarás el plástico. (Now you will throw the plastic.)
Ahora sí tocarás la pared. (Now you will touch the wall.)	Ahora sí tocarás la ventana. (Now you will touch the window.)
Affirmative sentences	**No recognition sentences**
Ahora sí abrirás la cerveza.	

(Now you will open the beer.)	
Ahora sí abrirás el abanico. (Now you will open the fan.)	
Ahora sí abrirás el paraguas. (Now you will open the umbrella.)	
Ahora sí abrirás la jaula. (Now you will open the cage.)	
Ahora sí abrirás la gaveta. (Now you will open the drawer.)	
Ahora sí abrirás la hucha. (Now you will open the cash box.)	
Ahora sí abrirás el champán. (Now you will open the champagne.)	
Ahora sí abrirás la nevera. (Now you will open the fridge.)	
Ahora sí abrirás el depósito. (Now you will open the deposit.)	
Ahora sí amarrarás los zapatos. (Now you will tie the shoes.)	
Ahora sí amarrarás la venda. (Now you will tie the bandage.)	
Ahora sí amarrarás el perro. Now you will tie the dog.)	
Ahora sí amarrarás la correa. (Now you will tie the strap.)	
Ahora sí amarrarás los cordones. (Now you will tie the laces.)	
Ahora sí amarrarás la cuerda. (Now you will tie the rope.)	
Ahora sí amarrarás la cometa. (Now you will tie the kite.)	
Ahora sí apretarás la esponja. (Now you will squeeze the sponge.)	
Ahora sí apretarás el bombillo. (Now you will tighten the light bulb.)	
Ahora sí apretarás el barro. (Now you will squeeze the mud.)	
Ahora sí apretarás la tuerca. (Now you will tighten the nut.)	
Ahora sí apretarás las esposas. (Now you will tighten the handcuffs.)	
Ahora sí apretarás la nudo. (Now you will tighten the knot.)	

Ahora sí apretarás el esparto. (Now you will tighten the esparto.)	
Ahora sí apretarás el botón. (Now you will press the button.)	
Ahora sí cerrarás el maletero. (Now you will close the trunk.)	
Ahora sí cerrarás la fiambrera. (Now you will close the lunch box.)	
Ahora sí cerrarás el cofre. (Now you will close the chest.)	
Ahora sí cerrarás el armario. (Now you will close the closet.)	
Ahora sí cerrarás el candado. (Now you will close the padlock.)	
Ahora sí cerrarás la olla. (Now you will close the pot.)	
Ahora sí cerrarás el baúl. (Now you will close the trunk.)	
Ahora sí cerrarás el sobre. (Now you will close the envelope.)	
Ahora sí cerrarás el estuche. (Now you will close the case.)	
Ahora sí cogerás la rosa. (Now you will take the rose.)	
Ahora sí cogerás el bocadillo. (Now you will take the sandwich.)	
Ahora sí cogerás el monedero. (Now you will take the purse.)	
Ahora sí cogerás el casco. (Now you will take the helmet.)	
Ahora sí cogerás la brocha. (Now you will take the brush.)	
Ahora sí cogerás el martillo. (Now you will take the hammer.)	
Ahora sí colgarás el vestido. (Now you will hang the dress.)	
Ahora sí colgarás el delantal. (Now you will hang the apron.)	
Ahora sí colgarás el albornoz. (Now you will hang the bathrobe.)	
Ahora sí colgarás el abrigo. (Now you will hang the coat.)	
Ahora sí colgarás la chaqueta.	

(Now you will hang the jacket.)	
Ahora sí colgarás el bolso. (Now you will hang the bag.)	
Ahora sí colgarás la toalla. (Now you will hang the towel.)	
Ahora sí colgarás las cortinas. (Now you will hang the curtains.)	
Ahora sí copiarás la carta. (Now you will copy the letter.)	
Ahora sí copiarás el resumen. (Now you will copy the summary.)	
Ahora sí copiarás la figura. (Now you will copy the figure.)	
Ahora sí copiarás el poema. (Now you will copy the poem.)	
Ahora sí copiarás la redacción. (Now you will copy the wording.)	
Ahora sí copiarás el documento. (Now you will copy the document.)	
Ahora sí cortarás un clavel. (Now you will cut a carnation.)	
Ahora sí cortarás la calabaza. (Now you will cut the pumpkin.)	
Ahora sí cortarás la tortilla. (Now you will cut the tortilla.)	
Ahora sí cortarás el pimiento. (Now you will cut the pepper.)	
Ahora sí cortarás el pepino. (Now you will cut the cucumber.)	
Ahora sí cortarás la cartulina. (Now you will cut the cardboard.)	
Ahora sí cortarás la lechuga. (Now you will cut the lettuce.)	
Ahora sí cortarás la cinta. (Now you will cut the tape.)	
Ahora sí doblarás el chaleco. (Now you will fold the vest.)	
Ahora sí doblarás el paño. (Now you will fold the cloth.)	
Ahora sí doblarás la rebeca. (Now you will fold the cardigan.)	
Ahora sí doblarás el suéter. (Now you will fold the sweater.)	

Ahora sí doblarás el folio. (Now you will fold the folio.)	
Ahora sí doblarás la colcha. (Now you will fold the quilt.)	
Ahora sí doblarás el papel. (Now you will fold the paper.)	
Ahora sí doblarás la chandal. (Now you will fold the tracksuit.)	
Ahora sí doblarás las sábanas. (Now you will fold the sheets.)	
Ahora sí encenderás el mechero. (Now you will light the lighter.)	
Ahora sí encenderás la linterna. (Now you will turn on the flashlight.)	
Ahora sí encenderás un fósforo. (Now you will light a match.)	
Ahora sí encenderás la radio. (Now you will turn on the radio.)	
Ahora sí encenderás el horno. (Now you will turn on the oven.)	
Ahora sí encenderás la lámpara. (Now you will light the lamp.)	
Ahora sí encenderás la hoguera. (Now you will light the bonfire.)	
Ahora sí fregarás el piso. (Now you will scrub the floor.)	
Ahora sí fregarás el caldero. (Now you will scrub the cauldron.)	
Ahora sí fregarás los platos. (Now you will scrub the dishes.)	
Ahora sí fregarás los cubiertos. (Now you will scrub the cutlery.)	
Ahora sí fregarás el jarrón. (Now you will scrub the vase.)	
Ahora sí fregarás el vaso. (Now you will scrub the glass.)	
Ahora sí fregarás la escalera. (Now you will scrub the stairs.)	
Ahora sí fregarás el suelo. (Now you will scrub the floor.)	
Ahora sí fregarás la sartén. (Now you will scrub the pan.)	
Ahora sí guardarás los mocasines.	

(Now you will collect the loafers.)	
Ahora sí guardarás el regalo. (Now you will collect the gift.)	
Ahora sí guardarás la mochila. (Now you will collect the backpack.)	
Ahora sí guardarás la fotografía. (Now you will collect the photograph.)	
Ahora sí guardarás el sello. (Now you will collect the seal.)	
Ahora sí guardarás el título. (Now you will save the title.)	
Ahora sí guardarás la baraja. (Now you will collect the deck.)	
Ahora sí guardarás las lentillas. (Now you will collect the lenses.)	
Ahora sí guardarás el lápiz. (Now you will collect the pencil.)	
Ahora sí levantarás la silla. (Now you will lift the chair.)	
Ahora sí levantarás la carpeta. (Now you will lift the folder.)	
Ahora sí levantarás el libro. (Now you will lift the book.)	
Ahora sí levantarás la maceta. (Now you will lift the pot.)	
Ahora sí levantarás la mano. (Now you will raise your hand.)	
Ahora sí levantarás la estantería. (Now you will lift the shelf.)	
Ahora sí levantarás la manta. (Now you will lift the blanket.)	
Ahora sí levantarás las pesas. (Now you will lift the weights.)	
Ahora sí limpiarás la repisa. (Now you will clean the shelf.)	
Ahora sí limpiarás las botas. (Now you will clean the boots.)	
Ahora sí limpiarás la bañera. (Now you will clean the bathtub.)	
Ahora sí limpiarás el espejo. (Now you will clean the mirror.)	
Ahora sí limpiarás la azotea. (Now you will clean the roof.)	

Ahora sí limpiarás la persiana. (Now you will clean the shutter.)	
Ahora sí limpiarás el cuchillo. (Now you will clean the knife.)	
Ahora sí limpiarás el balcón. (Now you will clean the balcony.)	
Ahora sí limpiarás las gafas. (Now you will clean the glasses.)	
Ahora sí limpiarás las copas. (Now you will clean the glasses.)	
Ahora sí moverás el ratón. (Now you will move the mouse.)	
Ahora sí moverás los pedales. (Now you will move the pedals.)	
Ahora sí moverás el sillón. (Now you will move the chair.)	
Ahora sí moverás la cuchara. (Now you will move the spoon.)	
Ahora sí moverás el volante. (Now you will move the steering wheel.)	
Ahora sí moverás los dedos. (Now you will move your fingers.)	
Ahora sí moverás la cuna. (Now you will move the crib.)	
Ahora sí moverás la sombrilla. (Now you will move the umbrella.)	
Ahora sí moverás la mesa. (Now you will move the table.)	
Ahora sí moverás el manillar. (Now you will move the handlebar.)	
Ahora sí pelarás los cacahuetes. (Now you will peel the peanuts.)	
Ahora sí pelarás las papas. (Now you will peel the potatoes.)	
Ahora sí pelarás la cebolla. (Now you will peel the onion.)	
Ahora sí pelarás el plátano. (Now you will peel the banana.)	
Ahora sí pelarás la papaya. (Now you will peel the papaya.)	
Ahora sí pelarás la naranja. (Now you will peel the orange.)	
Ahora sí pelarás el kiwi.	

(Now you will peel the kiwi.)	
Ahora sí pelarás la pera. (Now you will peel the pear.)	
Ahora sí plancharás el mantel. (Now you will iron the tablecloth.)	
Ahora sí plancharás el vestido. (Now you will iron the dress.)	
Ahora sí plancharás la falda. (Now you will iron the skirt.)	
Ahora sí plancharás el traje. (Now you will iron the suit.)	
Ahora sí plancharás la corbata. (Now you will iron the tie.)	
Ahora sí plancharás las bermudas. (Now you will iron the shorts.)	
Ahora sí plancharás el pañuelo. (Now you will iron the handkerchief.)	
Ahora sí regarás el jardín. (Now you will water the garden.)	
Ahora sí regarás la violeta. (Now you will water the violet.)	
Ahora sí regarás el rosal. (Now you will water the rose bush.)	
Ahora sí regarás las plantas. (Now you will water the plants.)	
Ahora sí regarás el geranio. (Now you will water the geranium.)	
Ahora sí regarás el helecho. (Now you will water the fern.)	
Ahora sí regarás el geranio. (Now you will water the geranium.)	
Ahora sí regarás la huerta. (Now you will water the garden.)	
Ahora sí regarás la orquídea. (Now you will water the orchid.)	
Ahora sí servirás el postre. (Now you will serve dessert.)	
Ahora sí servirás la leche. (Now you will serve the milk.)	
Ahora sí servirás la tarta. (Now you will serve the cake.)	
Ahora sí servirás el jamón. (Now you will serve the ham.)	

Ahora sí servirás la ensalada. (Now you will serve the salad.)	
Ahora sí servirás la empanada. (Now you will serve the empanada.)	
Ahora sí servirás el puchero. (Now you will serve the pot.)	
Ahora sí servirás el caldo. (Now you will serve the broth.)	
Ahora sí servirás el pescado. (Now you will serve the fish.)	
Ahora sí tirarás el disco. (Now you will throw the disc.)	
Ahora sí tirarás la factura. (Now you will throw the bill.)	
Ahora sí tirarás el bumerán. (Now you will throw the boomerang.)	
Ahora sí tirarás la flecha. (Now you will shoot the arrow.)	
Ahora sí tirarás la moneda. (Now you will flip the coin.)	
Ahora sí tirarás la pelota. (Now you will throw the ball.)	
Ahora sí tocarás el timbre. (Now you will ring the bell.)	
Ahora sí tocarás el tambor. (Now you will play the drum.)	
Ahora sí tocarás la flauta. (Now you will play the flute.)	
Ahora sí tocarás las maracas. (Now you will play the maracas.)	
Ahora sí tocarás la pandereta. (Now you will play the tambourine.)	
Ahora sí tocarás el arpa. (Now you will play the harp.)	
Ahora sí tocarás la pita. (Now you will play the pita.)	
Ahora sí tocarás el piano. (Now you will play the piano.)	
Negative sentences	**Identical recognition sentences**
Ahora no abrirás la botella. (Now you will not open the bottle.)	Ahora no abrirás la botella. (Now you will not open the bottle.)
Ahora no abrirás el vino.	Ahora no abrirás el vino.

(Now you will not open the wine.)	(Now you will not open the wine.)
Ahora no abrirás el grifo. (Now you will not open the tap.)	Ahora no abrirás el grifo. (Now you will not open the tap.)
Ahora no amarrarás el globo. (Now you will not tie the balloon.)	Ahora no amarrarás el globo. (Now you will not tie the balloon.)
Ahora no amarrarás las sandalias. (Now you will not tie the sandals.)	Ahora no amarrarás las sandalias. (Now you will not tie the sandals.)
Ahora no apretarás el vendaje. (Now you will not tighten the bandage.)	Ahora no apretarás el vendaje. (Now you will not tighten the bandage.)
Ahora no cerrarás el tarro. (Now you will not close the jar.)	Ahora no cerrarás el tarro. (Now you will not close the jar.)
Ahora no cogerás el bolígrafo. (Now you will not take the pen.)	Ahora no cogerás el bolígrafo. (Now you will not take the pen.)
Ahora no cogerás las llaves. (Now you will not take the keys.)	Ahora no cogerás las llaves. (Now you will not take the keys.)
Ahora no cogerás el flotador. (Now you will not take the float.)	Ahora no cogerás el flotador. (Now you will not take the float.)
Ahora no colgarás el cuadro. (Now you will not hang the painting.)	Ahora no colgarás el cuadro. (Now you will not hang the painting.)
Ahora no copiarás la postal. (Now you will not copy the postcard.)	Ahora no copiarás la postal. (Now you will not copy the postcard.)
Ahora no copiarás la dirección. (Now you will not copy the address.)	Ahora no copiarás la dirección. (Now you will not copy the address.)
Ahora no copiarás una espiral. (Now you will not copy a spiral.)	Ahora no copiarás una espiral. (Now you will not copy a spiral.)
Ahora no cortarás la leña. (Now you will not cut the wood.)	Ahora no cortarás la leña. (Now you will not cut the wood.)
Ahora no cortarás la manzana. (Now you will not cut the apple.)	Ahora no cortarás la manzana. (Now you will not cut the apple.)
Ahora no cortarás el bizcochón. (Now you will not cut the cake.)	Ahora no cortarás el bizcochón. (Now you will not cut the cake.)
Ahora no cortarás el tomate. (Now you will not cut the tomato.)	Ahora no cortarás el tomate. (Now you will not cut the tomato.)
Ahora no cortarás el pastel. (Now you will not cut the cake.)	Ahora no cortarás el pastel. (Now you will not cut the cake.)
Ahora no doblarás el billete. (Now you will not fold the ticket.)	Ahora no doblarás el billete. (Now you will not fold the ticket.)
Ahora no doblarás el edredón. (Now you will not fold the duvet.)	Ahora no doblarás el edredón. (Now you will not fold the duvet.)
Ahora no doblarás los calcetines. (Now you will not fold the socks.)	Ahora no doblarás los calcetines. (Now you will not fold the socks.)
Ahora no encenderás la tele. (Now you will not turn on the TV.)	Ahora no encenderás la tele. (Now you will not turn on the TV.)

Ahora no encenderás la vela. (Now you will not light the candle.)	Ahora no encenderás la vela. (Now you will not light the candle.)
Ahora no fregarás la taza. (Now you will not scrub the cup.)	Ahora no fregarás la taza. (Now you will not scrub the cup.)
Ahora no guardarás el cargador. (Now you will not collect the charger.)	Ahora no guardarás el cargador. (Now you will not collect the charger.)
Ahora no guardarás el pergamino. (Now you will not collect the parchment.)	Ahora no guardarás el pergamino. (Now you will not collect the parchment.)
Ahora no guardarás el puzzle. (Now you will not collect the puzzle.)	Ahora no guardarás el puzzle. (Now you will not collect the puzzle.)
Ahora no guardarás el sándwich. (Now you will not collect the sandwich.)	Ahora no guardarás el sándwich. (Now you will not collect the sandwich.)
Ahora no levantarás la alfombra. (Now you will not lift the carpet.)	Ahora no levantarás la alfombra. (Now you will not lift the carpet.)
Ahora no levantarás el sofá. (Now you will not lift the sofa.)	Ahora no levantarás el sofá. (Now you will not lift the sofa.)
Ahora no levantarás el bastón. (Now you will not lift the cane.)	Ahora no levantarás el bastón. (Now you will not lift the cane.)
Ahora no limpiarás el mueble. (Now you will not clean the furniture.)	Ahora no limpiarás el mueble. (Now you will not clean the furniture.)
Ahora no moverás la ficha. (Now you will not move the card.)	Ahora no moverás la ficha. (Now you will not move the card.)
Ahora no moverás la bicicleta. (Now you will not move the bike.)	Ahora no moverás la bicicleta. (Now you will not move the bike.)
Ahora no moverás la pancarta. (Now you will not move the banner.)	Ahora no moverás la pancarta. (Now you will not move the banner.)
Ahora no moverás la mano. (Now you will not move your hand.)	Ahora no moverás la mano. (Now you will not move your hand.)
Ahora no plancharás el pañuelo. (Now you will not iron the handkerchief.)	Ahora no plancharás el pañuelo. (Now you will not iron the handkerchief.)
Ahora no plancharás la blusa. (Now you will not iron the blouse.)	Ahora no plancharás la blusa. (Now you will not iron the blouse.)
Ahora no plancharás el pantalón. (Now you will not iron the pants.)	Ahora no plancharás el pantalón. (Now you will not iron the pants.)
Ahora no plancharás las servilletas. (Now you will not iron the napkins.)	Ahora no plancharás las servilletas. (Now you will not iron the napkins.)
Ahora no regarás las flores. (Now you will not water the flowers.)	Ahora no regarás las flores. (Now you will not water the flowers.)
Ahora no tirarás los dados. (Now you will not throw the dice.)	Ahora no tirarás los dados. (Now you will not throw the dice.)
Ahora no tirarás la canica.	Ahora no tirarás la canica.

(Now you will not throw the marble.)	(Now you will not throw the marble.)
Ahora no tirarás una piedra. (Now you will not throw a stone.)	Ahora no tirarás una piedra. (Now you will not throw a stone.)
Ahora no tocarás las castañuelas. (Now you will not play the castanets.)	Ahora no tocarás las castañuelas. (Now you will not play the castanets.)
Ahora no tocarás la guitarra. (Now you will not play the guitar.)	Ahora no tocarás la guitarra. (Now you will not play the guitar.)
Ahora no tocarás el violín. (Now you will not play the violin.)	Ahora no tocarás el violín. (Now you will not play the violin.)
Negative sentences	**Polarity-modified recognition sentences**
Ahora no abrirás la ventana. (Now you will not open the window.)	Ahora sí abrirás la ventana. (Now you will open the window.)
Ahora no abrirás la lata. (Now you will not open the can.)	Ahora sí abrirás la lata. (Now you will open the can.)
Ahora no amarrarás el gato. (Now you will not tie the cat.)	Ahora sí amarrarás el gato. (Now you will tie the cat.)
Ahora no apretarás la tecla. (Now you will not press the key.)	Ahora sí apretarás la tecla. (Now you will press the key.)
Ahora no cerrarás la guantera. (Now you will not close the glove compartment.)	Ahora sí cerrarás la guantera. (Now you will close the glove compartment.)
Ahora no cogerás las tijeras. (Now you will not take the scissors.)	Ahora sí cogerás las tijeras. (Now you will take the scissors.)
Ahora no copiarás el dibujo. (Now you will not copy the drawing.)	Ahora sí copiarás el dibujo. (Now you will copy the drawing.)
Ahora no cortarás el queso. (Now you will not cut the cheese.)	Ahora sí cortarás el queso. (Now you will cut the cheese.)
Ahora no encenderás la luz. (Now you will not turn on the light.)	Ahora sí encenderás la luz. (Now you will turn on the light.)
Ahora no encenderás el ventilador. (Now you will not turn on the fan.)	Ahora sí encenderás el ventilador. (Now you will turn on the fan.)
Ahora no levantarás el lápiz. (Now you will not lift the pencil.)	Ahora sí levantarás el lápiz. (Now you will lift the pencil.)
Ahora no moverás la bandera. (Now you will not move the flag.)	Ahora sí moverás la bandera. (Now you will move the flag.)
Ahora no pelarás las castañas. (Now you will not peel the chestnuts.)	Ahora sí pelarás las castañas. (Now you will peel the chestnuts.)
Ahora no pelarás la mandarina. (Now you will not peel the tangerine.)	Ahora sí pelarás la mandarina. (Now you will peel the tangerine.)
Ahora no regarás el césped. (Now you will not water the lawn.)	Ahora sí regarás el césped. (Now you will water the lawn.)
Ahora no servirás el flan.	Ahora sí servirás el flan.

(Now you will not serve the flan.)	(Now you will serve the flan.)
Ahora no servirás la sidra. (Now you will not serve the cider.)	Ahora sí servirás la sidra. (Now you will serve the cider.)
Ahora no tirarás la basura. (Now you will not throw the garbage.)	Ahora sí tirarás la basura. (Now you will throw the garbage.)
Negative sentences	**Verb-modified recognition sentences**
Ahora no abrirás el equipaje. (Now you will not open the luggage.)	Ahora no perderás el equipaje. (Now you will not lose the luggage.)
Ahora no apretarás la plastilina. (Now you will not pull the plasticine.)	Ahora no comprarás la plastilina. (Now you will not buy the plasticine.)
Ahora no apretarás el tornillo. (Now you will not tighten the screw.)	Ahora no esconderás el tornillo. (Now you will not hide the screw.)
Ahora no cogerás las uvas. (Now you will not take the grapes.)	Ahora no pisarás las uvas. (Now you will not step on the grapes.)
Ahora no colgarás la percha. (Now you will not hang the hanger.)	Ahora no pintarás la percha. (Now you will not paint the hanger.)
Ahora no copiarás el informe. (Now you will not copy the report.)	Ahora no enviarás el informe. (Now you will not send the report.)
Ahora no copiarás el email. (Now you will not copy the email.)	Ahora no borrarás el email. (Now you will not delete the email.)
Ahora no cortarás el pan. (Now you will not cut the bread.)	Ahora no amasarás el pan. (Now you will not knead the bread.)
Ahora no encenderás el ordenador. (Now you will not turn on the computer.)	Ahora no alquilarás el ordenador. (Now you will not rent the computer.)
Ahora no fregarás la vajilla. (Now you will not scrub the dishes.)	Ahora no romperás la vajilla. (Now you will not break the dishes.)
Ahora no fregarás el patio. (Now you will not scrub the patio.)	Ahora no techarás el patio. (Now you will not roof the patio.)
Ahora no guardarás el anillo. (Now you will not collect the ring.)	Ahora no devolverás el anillo. (Now you will not return the ring.)
Ahora no guardarás la tarjeta. (Now you will not collect the card.)	Ahora no solicitarás la tarjeta. (Now you will not request the card.)
Ahora no moverás la manivela. (Now you will not move the crank.)	Ahora no fabricarás la manivela. (Now you will not make the crank.)
Negative sentences	**Noun-modified recognition sentences**
Ahora no amarrarás el cinturón. (Now you will not tie the belt.)	Ahora no amarrarás el cable. (Now you will not tie the cable.)
Ahora no amarrarás la bolsa. (Now you will not tie the bag.)	Ahora no amarrarás la correa. (Now you will not tie the strap.)
Ahora no cerrarás la cancela. (Now you will not close the gate.)	Ahora no cerrarás la habitación. (Now you will not close the room.)

Ahora no cogerás un clínex. (Now you will not take a tissue.)	Ahora no cogerás un avión. (Now you will not catch a plane.)
Ahora no colgarás el póster. (Now you will not hang the poster.)	Ahora no colgarás el hábito. (Now you will not give up the habit.)
Ahora no copiarás la frase. (Now you will not copy the phrase.)	Ahora no copiarás la carta. (Now you will not copy the letter.)
Ahora no cortarás el filete. (Now you will not cut the steak.)	Ahora no cortarás el calabacín. (Now you will not cut the zucchini.)
Ahora no limpiarás la baranda. (Now you will not clean the railing.)	Ahora no limpiarás la bañera. (Now you will not clean the bathtub.)
Ahora no pelarás el aguacate. (Now you will not peel the avocado.)	Ahora no pelarás el limón. (Now you will not peel the lemon.)
Ahora no pelarás los ajos. (Now you will not peel the garlic.)	Ahora no pelarás los melones. (Now you will not peel the melons.)
Ahora no plancharás la camisa. (Now you will not iron the shirt.)	Ahora no plancharás la americana. (Now you will not iron the jacket.)
Ahora no regarás la enredadera. (Now you will not water the vine.)	Ahora no regarás las plataneras. (Now you will not water the banana trees.)
Ahora no servirás el zumo. (Now you will not serve the juice.)	Ahora no servirás el gofio. (Now you will not serve the gofio.)
Ahora no tirarás el balón. (Now you will not throw the ball.)	Ahora no tirarás el boleto. (Now you will not throw the ticket.)
Ahora no tirarás el dardo. (Now you will not throw the dart.)	Ahora no tirarás el plástico. (Now you will not throw the plastic.)
Ahora no tocarás la pared. (Now you will not touch the wall.)	Ahora no tocarás la ventana. (Now you will not touch the window.)
Negative sentences	**No recognition sentences**
Ahora no abrirás la cerveza. (Now you will not open the beer.)	
Ahora no abrirás el abanico. (Now you will not open the fan.)	
Ahora no abrirás el paraguas. (Now you will not open the umbrella.)	
Ahora no abrirás la jaula. (Now you will not open the cage.)	
Ahora no abrirás la gaveta. (Now you will not open the drawer.)	
Ahora no abrirás la hucha. (Now you will not open the cash box.)	
Ahora no abrirás el champán. (Now you will not open the champagne.)	

Ahora no abrirás la nevera. (Now you will not open the fridge.)	
Ahora no abrirás el depósito. (Now you will not open the deposit.)	
Ahora no amarrarás los zapatos. (Now you will not tie the shoes.)	
Ahora no amarrarás la venda. (Now you will not tie the bandage.)	
Ahora no amarrarás el perro. Now you will not tie the dog.)	
Ahora no amarrarás la correa. (Now you will not tie the strap.)	
Ahora no amarrarás los cordones. (Now you will not tie the laces.)	
Ahora no amarrarás la cuerda. (Now you will not tie the rope.)	
Ahora no amarrarás la cometa. (Now you will not tie the kite.)	
Ahora no apretarás la esponja. (Now you will not squeeze the sponge.)	
Ahora no apretarás el bombillo. (Now you will not tighten the light bulb.)	
Ahora no apretarás el barro. (Now you will not squeeze the mud.)	
Ahora no apretarás la tuerca. (Now you will not tighten the nut.)	
Ahora no apretarás las esposas. (Now you will not tighten the handcuffs.)	
Ahora no apretarás la nudo. (Now you will not tighten the knot.)	
Ahora no apretarás el esparto. (Now you will not tighten the esparto.)	
Ahora no apretarás el botón. (Now you will not press the button.)	
Ahora no cerrarás el maletero. (Now you will not close the trunk.)	
Ahora no cerrarás la fiambrera. (Now you will not close the lunch box.)	
Ahora no cerrarás el cofre. (Now you will not close the chest.)	
Ahora no cerrarás el armario. (Now you will not close the closet.)	
Ahora no cerrarás el candado.	

(Now you will not close the padlock.)	
Ahora no cerrarás la olla. (Now you will not close the pot.)	
Ahora no cerrarás el baúl. (Now you will not close the trunk.)	
Ahora no cerrarás el sobre. (Now you will not close the envelope.)	
Ahora no cerrarás el estuche. (Now you will not close the case.)	
Ahora no cogerás la rosa. (Now you will not take the rose.)	
Ahora no cogerás el bocadillo. (Now you will not take the sandwich.)	
Ahora no cogerás el monedero. (Now you will not take the purse.)	
Ahora no cogerás el casco. (Now you will not take the helmet.)	
Ahora no cogerás la brocha. (Now you will not take the brush.)	
Ahora no cogerás el martillo. (Now you will not take the hammer.)	
Ahora no colgarás el vestido. (Now you will not hang the dress.)	
Ahora no colgarás el delantal. (Now you will not hang the apron.)	
Ahora no colgarás el albornoz. (Now you will not hang the bathrobe.)	
Ahora no colgarás el abrigo. (Now you will not hang the coat.)	
Ahora no colgarás la chaqueta. (Now you will not hang the jacket.)	
Ahora no colgarás el bolso. (Now you will not hang the bag.)	
Ahora no colgarás la toalla. (Now you will not hang the towel.)	
Ahora no colgarás las cortinas. (Now you will not hang the curtains.)	
Ahora no copiarás la carta. (Now you will not copy the letter.)	
Ahora no copiarás el resumen. (Now you will not copy the summary.)	
Ahora no copiarás la figura. (Now you will not copy the figure.)	

Ahora no copiarás el poema. (Now you will not copy the poem.)	
Ahora no copiarás la redacción. (Now you will not copy the wording.)	
Ahora no copiarás el documento. (Now you will not copy the document.)	
Ahora no cortarás un clavel. (Now you will not cut a carnation.)	
Ahora no cortarás la calabaza. (Now you will not cut the pumpkin.)	
Ahora no cortarás la tortilla. (Now you will not cut the tortilla.)	
Ahora no cortarás el pimiento. (Now you will not cut the pepper.)	
Ahora no cortarás el pepino. (Now you will not cut the cucumber.)	
Ahora no cortarás la cartulina. (Now you will not cut the cardboard.)	
Ahora no cortarás la lechuga. (Now you will not cut the lettuce.)	
Ahora no cortarás la cinta. (Now you will not cut the tape.)	
Ahora no doblarás el chaleco. (Now you will not fold the vest.)	
Ahora no doblarás el paño. (Now you will not fold the cloth.)	
Ahora no doblarás la rebeca. (Now you will not fold the cardigan.)	
Ahora no doblarás el suéter. (Now you will not fold the sweater.)	
Ahora no doblarás el folio. (Now you will not fold the folio.)	
Ahora no doblarás la colcha. (Now you will not fold the quilt.)	
Ahora no doblarás el papel. (Now you will not fold the paper.)	
Ahora no doblarás la chandal. (Now you will not fold the tracksuit.)	
Ahora no doblarás las sábanas. (Now you will not fold the sheets.)	
Ahora no encenderás el mechero. (Now you will not light the lighter.)	
Ahora no encenderás la linterna.	

(Now you will not turn on the flashlight.)	
Ahora no encenderás un fósforo. (Now you will not light a match.)	
Ahora no encenderás la radio. (Now you will not turn on the radio.)	
Ahora no encenderás el horno. (Now you will not turn on the oven.)	
Ahora no encenderás la lámpara. (Now you will not light the lamp.)	
Ahora no encenderás la hoguera. (Now you will not light the bonfire.)	
Ahora no fregarás el piso. (Now you will not scrub the floor.)	
Ahora no fregarás el caldero. (Now you will not scrub the cauldron.)	
Ahora no fregarás los platos. (Now you will not scrub the dishes.)	
Ahora no fregarás los cubiertos. (Now you will not scrub the cutlery.)	
Ahora no fregarás el jarrón. (Now you will not scrub the vase.)	
Ahora no fregarás el vaso. (Now you will not scrub the glass.)	
Ahora no fregarás la escalera. (Now you will not scrub the stairs.)	
Ahora no fregarás el suelo. (Now you will not scrub the floor.)	
Ahora no fregarás la sartén. (Now you will not scrub the pan.)	
Ahora no guardarás los mocasines. (Now you will not collect the loafers.)	
Ahora no guardarás el regalo. (Now you will not collect the gift.)	
Ahora no guardarás la mochila. (Now you will not collect the backpack.)	
Ahora no guardarás la fotografía. (Now you will not collect the photograph.)	
Ahora no guardarás el sello. (Now you will not collect the seal.)	
Ahora no guardarás el título. (Now you will not save the title.)	
Ahora no guardarás la baraja.	

(Now you will not collect the deck.)	
Ahora no guardarás las lentillas. (Now you will not collect the lenses.)	
Ahora no guardarás el lápiz. (Now you will not collect the pencil.)	
Ahora no levantarás la silla. (Now you will not lift the chair.)	
Ahora no levantarás la carpeta. (Now you will not lift the folder.)	
Ahora no levantarás el libro. (Now you will not lift the book.)	
Ahora no levantarás la maceta. (Now you will not lift the pot.)	
Ahora no levantarás la mano. (Now you will not raise your hand.)	
Ahora no levantarás la estantería. (Now you will not lift the shelf.)	
Ahora no levantarás la manta. (Now you will not lift the blanket.)	
Ahora no levantarás las pesas. (Now you will not lift the weights.)	
Ahora no limpiarás la repisa. (Now you will not clean the shelf.)	
Ahora no limpiarás las botas. (Now you will not clean the boots.)	
Ahora no limpiarás la bañera. (Now you will not clean the bathtub.)	
Ahora no limpiarás el espejo. (Now you will not clean the mirror.)	
Ahora no limpiarás la azotea. (Now you will not clean the roof.)	
Ahora no limpiarás la persiana. (Now you will not clean the shutter.)	
Ahora no limpiarás el cuchillo. (Now you will not clean the knife.)	
Ahora no limpiarás el balcón. (Now you will not clean the balcony.)	
Ahora no limpiarás las gafas. (Now you will not clean the glasses.)	
Ahora no limpiarás las copas. (Now you will not clean the glasses.)	
Ahora no moverás el ratón. (Now you will not move the mouse.)	

Ahora no moverás los pedales. (Now you will not move the pedals.)	
Ahora no moverás el sillón. (Now you will not move the chair.)	
Ahora no moverás la cuchara. (Now you will not move the spoon.)	
Ahora no moverás el volante. (Now you will not move the steering wheel.)	
Ahora no moverás los dedos. (Now you will not move your fingers.)	
Ahora no moverás la cuna. (Now you will not move the crib.)	
Ahora no moverás la sombrilla. (Now you will not move the umbrella.)	
Ahora no moverás la mesa. (Now you will not move the table.)	
Ahora no moverás el manillar. (Now you will not move the handlebar.)	
Ahora no pelarás los cacahuetes. (Now you will not peel the peanuts.)	
Ahora no pelarás las papas. (Now you will not peel the potatoes.)	
Ahora no pelarás la cebolla. (Now you will not peel the onion.)	
Ahora no pelarás el plátano. (Now you will not peel the banana.)	
Ahora no pelarás la papaya. (Now you will not peel the papaya.)	
Ahora no pelarás la naranja. (Now you will not peel the orange.)	
Ahora no pelarás el kiwi. (Now you will not peel the kiwi.)	
Ahora no pelarás la pera. (Now you will not peel the pear.)	
Ahora no plancharás el mantel. (Now you will not iron the tablecloth.)	
Ahora no plancharás el vestido. (Now you will not iron the dress.)	
Ahora no plancharás la falda. (Now you will not iron the skirt.)	
Ahora no plancharás el traje. (Now you will not iron the suit.)	

Ahora no plancharás la corbata. (Now you will not iron the tie.)	
Ahora no plancharás las bermudas. (Now you will not iron the shorts.)	
Ahora no plancharás el pañuelo. (Now you will not iron the handkerchief.)	
Ahora no regarás el jardín. (Now you will not water the garden.)	
Ahora no regarás la violeta. (Now you will not water the violet.)	
Ahora no regarás el rosal. (Now you will not water the rose bush.)	
Ahora no regarás las plantas. (Now you will not water the plants.)	
Ahora no regarás el geranio. (Now you will not water the geranium.)	
Ahora no regarás el helecho. (Now you will not water the fern.)	
Ahora no regarás el geranio. (Now you will not water the geranium.)	
Ahora no regarás la huerta. (Now you will not water the garden.)	
Ahora no regarás la orquídea. (Now you will not water the orchid.)	
Ahora no servirás el postre. (Now you will not serve dessert.)	
Ahora no servirás la leche. (Now you will not serve the milk.)	
Ahora no servirás la tarta. (Now you will not serve the cake.)	
Ahora no servirás el jamón. (Now you will not serve the ham.)	
Ahora no servirás la ensalada. (Now you will not serve the salad.)	
Ahora no servirás la empanada. (Now you will not serve the empanada.)	
Ahora no servirás el puchero. (Now you will not serve the pot.)	
Ahora no servirás el caldo. (Now you will not serve the broth.)	
Ahora no servirás el pescado. (Now you will not serve the fish.)	

Ahora no tirarás el disco. (Now you will not throw the disc.)	
Ahora no tirarás la factura. (Now you will not throw the bill.)	
Ahora no tirarás el bumerán. (Now you will not throw the boomerang.)	
Ahora no tirarás la flecha. (Now you will not shoot the arrow.)	
Ahora no tirarás la moneda. (Now you will not flip the coin.)	
Ahora no tirarás la pelota. (Now you will not throw the ball.)	
Ahora no tocarás el timbre. (Now you will not ring the bell.)	
Ahora no tocarás el tambor. (Now you will not play the drum.)	
Ahora no tocarás la flauta. (Now you will not play the flute.)	
Ahora no tocarás las maracas. (Now you will not play the maracas.)	
Ahora no tocarás la pandereta. (Now you will not play the tambourine.)	
Ahora no tocarás el arpa. (Now you will not play the harp.)	
Ahora no tocarás la pita. (Now you will not play the pita.)	
Ahora no tocarás el piano. (Now you will not play the piano.)	

Filler sentences in Spanish and their English translations	
Affirmative sentences	**Identical recognition sentences**
Después sí bailarás el tajaraste. (Afterwards you will dance the tajaraste.)	Después sí bailarás el tajaraste. (Afterwards you will dance the tajaraste.)
Luego sí irás al despacho. (Thereafter you will go to the office.)	Luego sí irás al despacho. (Thereafter you will go to the office.)
Luego sí prepararás el chocolate. (Thereafter you will prepare the chocolate.)	Luego sí prepararás el chocolate. (Thereafter you will prepare the chocolate.)

Affirmative sentences	Polarity-modified recognition sentences
Después sí recogerás las entradas. (Afterwards you will collect the tickets.)	Después no recogerás las entradas. (Afterwards you will not collect the tickets.)
Affirmative sentences	**Verb-modified recognition sentences**
Después sí desayunarás la avena. (Afterwards you will have the oatmeal for breakfast.)	Después sí cultivarás la avena. (Afterwards you will grow the oats.)
Affirmative sentences	**Noun-modified recognition sentences**
Luego sí comprarás el batería. (Thereafter you will buy the battery.)	Luego sí comprarás el acordeón. (Thereafter you will buy the accordion.)
Affirmative sentences	**No recognition sentences**
Después sí visitarás al cardiólogo. (Afterwards you will visit the cardiologist.)	
Después sí pondrás el lavavajillas. (Afterwards you will put the dishwasher.)	
Después sí montarás a caballo. (Afterwards you will ride a horse.)	
Después sí leerás un libro. (Afterwards you will read a book.)	
Después sí jugarás al póker. (Afterwards you will play poker.)	
Después sí pondrás la alarma. (Afterwards you will set the alarm.)	
Después sí romperás la factura. (Afterwards you will break the bill.)	
Luego sí cobrarás el cheque. (Thereafter you will cash the check.)	
Luego sí cantarás una habanera. (Thereafter you will sing a habanera.)	
Luego sí irás de camping. (Thereafter you will go camping.)	
Luego sí irás al teatro. (Thereafter you will go to the theater.)	
Luego sí harás la compra. (Thereafter you will make the purchase.)	
Luego sí darás un paseo. (Thereafter you will go for a walk.)	

Luego sí irás de escalada. (Thereafter you will go climbing.)	
Negative sentences	**Identical recognition sentences**
Después no leerás el periódico (Afterwards you will not read the newspaper.)	Después no leerás el periódico (Afterwards you will not read the newspaper.)
Después no llamarás al taxi. (Afterwards you will not call the taxi.)	Después no llamarás al taxi. (Afterwards you will not call the taxi.)
Luego no envolverás el paquete. (Thereafter you will not wrap the package.)	Luego no envolverás el paquete. (Thereafter you will not wrap the package.)
Negative sentences	**Polarity-modified recognition sentences**
Luego no cantarás una folía. (Thereafter you will not sing a folía.)	Luego sí cantarás una folía. (Thereafter you will sing a folía.)
Negative sentences	**Verb-modified recognition sentences**
Después no venderás las golosinas. (Afterwards you will not sell the candies.)	Después no regalarás las golosinas. (Afterwards you will not give the candies.)
Negative sentences	**Noun-modified recognition sentences**
Después no recogerás la oficina. (Afterwards you will not clean up the office.)	Después no recogerás la despensa. (Afterwards you will not clean up the pantry.)
Negative sentences	**No recognition sentences**
Después no prepararás la velada. (Afterwards you will not prepare the evening.)	
Después no controlarás el azúcar. (Afterwards you will not control the sugar.)	
Después no visitarás al veterinario. (Afterwards you will not visit the vet.)	
Después no verás las noticias. (Afterwards you will not read the news.)	
Después no verás el documental. (Afterwards you will not read the documentary.)	
Después no alcanzarás la meta. (Afterwards you will not reach the goal.)	

Después no soltarás la paloma. (Afterwards you will not release the dove.)	
Luego no comprarás la moto. (Thereafter you will not buy the motorcycle.)	
Luego no irás al museo. (Thereafter you will not go to the museum.)	
Luego no irás al gimnasio. (Thereafter you will not go to the gym.)	
Luego no harás los deberes. (Thereafter you will not do the homework.)	
Luego no irás al cine. (Thereafter you will not go to the cinema.)	
Luego no hornearás el pavo. (Thereafter you will not bake the turkey.)	
Luego no saltarás a la comba. (Thereafter you will not jump the rope.)	

Appendix 3

Materials for Experiment 3

Experimental sentences in Spanish and their English translations

Affirmative sentences	Probe	Coherent continuation
Ya hay manzanas en la nevera. (There are already apples in the fridge.)	MANZANAS (APPLES)	Saca una manzana de la nevera y se la come. (He/She takes an apple out of the fridge and eats it.)
Ya tienen tinta en la impresora. (They already have ink in the printer.)	TINTA (INK)	La secretaria abre el archivo y lo imprime. (The secretary opens the file and prints it.)
Ya hay pulseras en la joyería. (There are already bracelets in the jewelry store.)	PULSERAS (BRACELETS)	Compra una pulsera para su amiga en la joyería. (He/She buys a bracelet for his/her friend at the jewelry store.)
Ya tienen tiritas en el botiquín. (They already have plasters in the medicine cabinet.)	TIRITAS (PLASTERS)	Toma una tirita y se la coloca en el dedo. (He/She takes a plaster and puts it on his/her finger.)
Ya tiene vestidos en el armario. (She already has dresses in the closet.)	VESTIDOS (DRESSES)	Elige un bonito vestido del armario para la fiesta. (She picks a nice dress from the closet for the party.)
Ya tienen mantas en el sofá. (They already have blankets on the couch.)	MANTAS (BLANKETS)	Se tapa con una manta ya que siente frío. (He/She covers himself/herself with a blanket since he/she feels cold.)
Ya tienen escoba para el piso. (They already have a broom for the floor.)	ESCOBA (BROOM)	Ella toma la escoba y barre el piso. (He/She takes the broom and sweeps the floor.)
Ya tiene pañuelo en su bolso. (He/She already has a	PAÑUELO (HANKERCHIEF)	Usa el pañuelo para limpiarse la mano. (He/She uses the handkerchief to

handkerchief in her bag.)		wipe his/her hand.)
Ya hay camisas en el armario. (There are already shirts in the closet.)	CAMISAS (SHIRTS)	Elige una camisa blanca para combinar con sus pantalones. (He selects a white shirt to match his pants.)
Ya hay cojines en el sofá. (There are already cushions on the sofa.)	COJINES (CUSHIONS)	Se apoya en los cojines para sentirse cómodo. (He/She leans on the cushions to feel comfortable.)
Ya tienen carteles en el pasillo. (They already have posters in the hallway.)	CARTELES (POSTERS)	Los carteles anuncian las nuevas películas. (The posters advertise the new movies.)
Ya hay peine en el tocador. (There is already a comb on the dresser.)	PEINE (COMB)	Se peina con el peine antes de salir por la mañana. (He/She combs his/her hair before going out in the morning.)
Ya tienen bebidas en el maletero. (They already have drinks in the trunk.)	BEBIDAS (DRINKS)	Cogen las bebidas del coche para tomarlas en la barbacoa. (They take the drinks from the car to have them on the barbecue.)
Ya tienen roturas en la ventanilla. (They already have cracks on the window.)	ROTURAS (CRACKS)	Llamará a un mecánico para reparar la ventanilla. (He/She will call a mechanic to repair the window.)
Ya tienen cerveza en los vasos. (They already have beer in the glasses.)	CERVEZA (BEER)	Bebe varios vasos de cerveza con sus amigos. (He/She drinks several glasses of beer with his/her friends.)
Ya hay corbatas para el traje. (There are already ties for the suit.)	CORBATAS (TIES)	Se pone una corbata gris para combinar con su traje. (He puts on a gray tie to match his suit.)
Ya tienen tijeras en el cajón. (They already have scissors in the drawer.)	TIJERAS (SCISSORS)	Saca las tijeras y corta la cuerda con ellas. (He/She takes out the scissors and cut the string with them.)
Ya tienen radio en el estante. (They already have radios on the shelf.)	RADIO (RADIO)	Enciende la radio para escuchar el programa. (He/She turns on the radio to listen to the program.)

Ya tienen anillos en la joyería. (They already have rings in the jewelry store.)	ANILLOS (RINGS)	Compra un anillo de oro para su prometida. (He buys a gold ring for his fiancee.)
Ya hay sandía en la cocina. (There is already watermelon in the kitchen.)	SANDÍA (WATERMELON)	Corta la sandía en pedazos y los comparte con su familia. (He/She cuts the watermelon into pieces and shares them with his/her family.)
Ya hay equipaje en el maletero. (There is already luggage is in the trunk.)	EQUIPAJE (LUGGAGE)	Llevará el equipaje al aeropuerto por su esposa. (He will take the luggage to the airport for his wife.)
Ya hay velas en el pastel. (There are already candles on the cake.)	VELAS (CANDLES)	Enciende las velas y canta la canción de cumpleaños. (He/She lights the candles and sings the birthday song.)
Ya hay etiqueta para el traje. (There is already a tag for the suit.)	ETIQUETA (TAG)	La etiqueta está atada al traje con un hilo negro. (The tag is tied to the suit with a black thread.)
Ya hay cuchara en la bandeja. (There is already a spoon on the tray.)	CUCHARA (SPOON)	Se comerá la sopa con la cuchara. (He/She will eat the soup with the spoon.)
Affirmative sentences	**Probe**	**Incoherent continuation**
Ya hay baterías en el cajón. (There are already batteries in the drawer.)	BATERÍAS (BATTERIES)	Sale a comprar baterías para el despertador. (He/She goes out to buy batteries for the alarm clock.)
Ya tienen toalla en el baño. (They already have a towel in the bathroom.)	TOALLA (TOWEL)	Después de ducharse no tiene con que secarse. (After the shower, he/she has nothing to dry his/her body.)
Ya hay móviles en la tienda. (There are already cellphones in the store.)	MÓVILES (CELLPHONES)	Tiene que ir a otra tienda para comprar un móvil. (He/She has to go to another store to buy a cellphone.)
Ya tienen helados en la cocina. (They already have icecreams in the kitchen.)	HELADOS (ICECREAMS)	El niño le pide a su padre que le compre helado. (The boy asks his father to buy him icecream.)

Ya tienen abrigo en el perchero. (They already have a coat on the rack.)	ABRIGO (COAT)	Porque la madre dobló el abrigo y lo puso en el armario. (Because the mother folded the coat and put it in the closet.)
Ya hay monos en la jaula. (There are already monkeys in the cage.)	MONOS (MONKEYS)	Porque los monos están jugando en el árbol. (Because the monkeys are playing in the tree.)
Ya hay tarjetas en su billetera. (There are already cards in his/her wallet.)	TARJETAS (CARDS)	Tiene que pagar el almuerzo con efectivo. (He/She has to pay for lunch with cash.)
Ya hay teléfono en su oficina. (There is already a telephone in his/her office.)	TELÉFONO (TELEPHONE)	Entonces llama a sus clientes con su móvil. (So he/she calls his/her customers with his/her cellphone.)
Ya tienen zumos en la cafetería. (They already have juices in the cafeteria.)	ZUMOS (JUICES)	Tiene que pedir café en lugar de zumo. (He/She has to ask for coffee instead of juice.)
Ya tiene llaves en su bolsillo. (He/She already has keys in his/her pocket.)	LLAVES (KEYS)	Entonces toca el timbre para que le abran la puerta. (So he/she rings the bell to open the door.)
Ya tiene monedas en su billetera. (He/She already has coins in his/her wallet.)	MONEDAS (COINS)	Tiene que compra el billete de tranvía con la tarjeta. (He/She has to buy the tram ticket with the card.)
Ya hay pollo en el microondas. (There's already chicken in the microwave.)	POLLO (CHICKEN)	Porque la madre sacó el pollo del microondas hace unos minutos. (Because the mother took the chicken out of the microwave a few minutes ago.)
Ya tienen frutas en el pastel. (They already have fruits on the cake.)	FRUTAS (FRUITS)	El pastel solo está hecho de chocolate y crema. (The cake is only made of chocolate and cream.)
Ya tienen galletas en la bolsa. (They already have cookies in the bag.)	GALLETAS (COOKIES)	Porque ayer no compró galletas en el mercado. (Because he/she didn't buy cookies at the market yesterday.)
Ya hay tenedor en la bandeja.	TENEDOR (FORK)	Entonces le pide al camarero que le traiga un tenedor.

(There is already a fork on the tray.)		(So he/she asks the waiter to bring him/her a fork.)
Ya tienen lirios en la floristería. (They already have lilies at the florist.)	LIRIOS (LILIES)	Entonces compra un ramo de rosas para su novia. (So he buys a bouquet of roses for his girlfriend.)
Ya hay sábana en su cama. (There is already a bedsheet on his/her bed.)	SÁBANA (BEDSHEET)	Entonces la madre extiende una sábana sobre su cama. (So the mother spreads a bedsheet over his/her bed.)
Ya hay papel en la impresora. (There is already paper in the printer.)	PAPEL (PAPER)	Entonces puso papel en la impresora para poder imprimir. (So he/she puts paper in the printer to be able to print.)
Ya hay alcohol en el botiquín. (There is already alcohol in the medicine cabinet.)	ALCOHOL (ALCOHOL)	Irá a la farmacia a comprar alcohol. (He/she will go to the pharmacy to buy alcohol.)
Ya tienen perros en el patio. (They already have dogs in the yard.)	PERROS (DOGS)	Los perros están en el sofá junto a su dueño. (The dogs are on the couch next to their owner.)
Ya tienen suciedad en la ventanilla. (They already have dirt on the window.)	SUCIEDAD (DIRT)	Porque ella limpió la ventanilla hace un momento. (Because he/she cleaned the window just now.)
Ya hay aceite en la sartén. (There is already oil in the pan.)	ACEITE (OIL)	Echa aceite en la sartén para freir el bistec. (He/She pours oil into the pan to fry the steak.)
Ya tiene sudor en su frente. (He/She already has sweat on his/her forehead.)	SUDOR (SWEAT)	Porque lo acaba de limpiar con una servilleta. (Because he/she just wiped it with a napkin.)
Ya hay refresco en los vasos. (There is already soda in the glasses.)	REFRESCO (SODA)	Porque a los invitados les gusta beber vino. (Because the guests like to drink wine.)
Affirmative sentences	**Probe**	**No continuation**
Ya hay crema en el frasco. (There is already cream in the jar.)	CREMA (CREAM)	

Ya tiene colcha en su cama. (He/She already has a quilt on his/her bed.)	COLCHA (QUILT)	
Ya hay botas en el estante. (There are already boots on the shelf.)	BOTAS (BOOTS)	
Ya tienen fideos en la olla. (They already have noodles in the pot.)	FIDEOS (NOODLES)	
Ya tienen setas en la cesta. (They already have mushrooms in the basket.)	SETAS (MUSHROOMS)	
Ya tienen jamón en la pizza. (They already have ham on the pizza.)	JAMÓN (HAM)	
Ya tienen candado en la puerta. (They already have a padlock on the door.)	CANDADO (PADLOCK)	
Ya hay champú en la peluquería. (There is already shampoo in the salon.)	CHAMPÚ (SHAMPOO)	
Ya tienen peras en la mesa. (They already have pears on the table.)	PERAS (PEARS)	
Ya hay gatos en el patio. (There are already cats in the yard.)	GATOS (CATS)	
Ya tienen revistas en la estantería. (They already have magazines on the shelf.)	REVISTAS (MAGAZINES)	
Ya hay teclado en el escritorio. (There is already keyboard on the desk.)	TECLADO (KEYBOARD)	
Ya hay chicles en su bolsillo. (There are already gums in his/her pocket.)	CHICLES (GUMS)	
Ya hay pudines en la cafetería.	PUDINES (PUDDINGS)	

(There are already puddings in the cafeteria.)		
Ya hay blusas en la lavadora. (There are already blouses in the washing machine.)	BLUSAS (BLOUSES)	
Ya hay maceta en el balcón. (There is already a flowerpot on the balcony.)	MACETA (FLOWERPOT)	
Ya hay dulces en la caja. (There are already sweets in the box.)	DULCES (SWEETS)	
Ya hay espresso en las tazas. (There is already espresso in the cups.)	ESPRESSO (ESPRESSO)	
Ya hay bistec en el plato. (There is already steak on the plate.)	BISTEC (STEAK)	
Ya hay queso en la pasta. (There is already cheese in the pasta.)	QUESO (CHEESE)	
Ya hay señales en el pasillo. (There are already signs in the hall.)	SEÑALES (SIGNS)	
Ya tienen gambas en el microondas. (They already have shrimps in the microwave.)	GAMBAS (SHRIMPS)	
Ya hay ensalada en el tazón. (There's already salad in the bowl.)	ENSALADA (SALAD)	
Ya tienen perfume en el tocador. (They already have perfume on the dresser.)	PERFUME (PERFUME)	
Ya hay bufanda en la percha. (There is already a scarf on the hanger.)	BUFANDA (SCARF)	
Ya tienen loros en la jaula. (They already have parrots in the cage.)	LOROS (PARROTS)	

Ya hay pijamas en la lavadora. (There are already pajamas in the washing machine.)	PIJAMAS (PAJAMAS)	
Ya tienen extintor en el edificio. (They already have a extinguisher in the building.)	EXTINTOR (EXTINGUISHER)	
Ya hay regalos en la caja. (There are already gifts in the box.)	REGALOS (GIFTS)	
Ya tienen leche en las tazas. (They already have milk in the cups.)	LECHE (MILK)	
Ya hay huesos en el plato. (There are already bones on the plate.)	HUESOS (BONES)	
Ya tienen cebolla en la pasta. (They already have onion in the pasta.)	CEBOLLA (ONION)	
Ya tiene brócoli en el tazón. (He/She already has broccoli in the bowl.)	BRÓCOLI (BROCCOLI)	
Ya hay dinero en su bolso. (There is already money in her purse.)	DINERO (MONEY)	
Ya tiene libros en su oficina. (He/She already has books in his/her office.)	LIBROS (BOOKS)	
Ya hay fregona para el piso. (There is already a mop for the floor.)	FREGONA (MOP)	
Ya hay cinturón para la falda. (There is already a belt for the skirt.)	CINTURÓN (BELT)	
Ya hay lápices en el estuche. (There are already pencils in the case.)	LÁPICES (PENCILS)	

Ya hay folletos en el buzón. (There are already brochures in the mailbox.)	FOLLETOS (BROCHURES)	
Ya tienen lechuga para el sándwich. (They already have lettuce for the sandwich.)	LECHUGA (LETTUCE)	
Ya hay tocino en la sartén. (There is already bacon in the pan.)	TOCINO (BACON)	
Ya tiene botones en el suéter. (He/She already has buttons on the sweater.)	BOTONES (BUTTONS)	
Ya hay nueces en el yogurt. (There are already nuts in the yogurt.)	NUECES (NUTS)	
Ya hay pesas en el gimnasio. (There are already dumbbells in the gym.)	PESAS (DUMBBELLS)	
Ya hay perlas para el sombrero. (There are already pearls for the hat.)	PERLAS (PEARLS)	
Ya tienen mayonesa en la hamburguesa. (They already have mayonnaise on the burger.)	MAYONESA (MAYONNAISE)	
Ya hay carne en la plancha. (There is already meat on the grill.)	CARNE (MEAT)	
Ya hay ciruelas en el frutero. (There are already plums in the fruit bowl.)	CIRUELAS (PLUMS)	
Ya tiene azúcar en el frasco. (He/She already has sugar in the jar.)	AZÚCAR (SUGAR)	
Ya tienen papayas en la nevera. (They already have papayas in the fridge.)	PAPAYAS (PAPAYAS)	

Ya hay jabón en el baño. (There is already soap in the bathroom.)	JABÓN (SOAP)	
Ya hay arroz en la olla. (There is already rice in the pot.)	ARROZ (RICE)	
Ya hay mangos en la cesta. (There are already mangos in the basket.)	MANGOS (MANGOS)	
Ya hay verdura en la pizza. (There is already vegetable on the pizza.)	VERDURA (VEGETABLE)	
Ya tienen cámaras en la tienda. (They already have cameras in store.)	CÁMARAS (CAMERAS)	
Ya hay timbre en la puerta. (There is already a bell at the door.)	TIMBRE (BELL)	
Ya tienen secador en la peluquería. (They already have a hairdryer in the hair salon.)	SECADOR (HAIRDRYER)	
Ya hay botella en la mesa. (There is already a bottle on the table.)	BOTELLA (BOTTLE)	
Ya hay novelas en la estantería. (There are already novels on the shelf.)	NOVELAS (NOVELS)	
Ya tienen carpeta en el escritorio. (They already have a folder on the desk.)	CARPETA (FOLDER)	
Ya tienen tirante para la falda. (They already have a strap for the skirt.)	TIRANTE (STRAP)	
Ya hay limones en la bolsa. (There are already lemons in the bag.)	LIMONES (LEMONS)	
Ya tienen reglas en el estuche.	REGLAS (RULERS)	

(They already have rulers in the case.)		
Ya hay cartas en el buzón. (There are already letters in the mailbox.)	CARTAS (LETTERS)	
Ya tienen huevos para el sándwich. (They already have eggs for the sandwich.)	HUEVOS (EGGS)	
Ya tiene broche en el suéter. (He/She already has a brooch on his/her sweater.)	BROCHE (BROOCH)	
Ya hay cereal en el yogurt. (There is already cereal in the yogurt.)	CEREAL (CEREAL)	
Ya hay plumas para el sombrero. (There are already feathers for the hat.)	PLUMAS (FEATHERS)	
Ya hay rosas en la floristería. (There are already roses at the florist.)	ROSAS (ROSES)	
Ya hay tomate en la hamburguesa. (There is already tomato in the burger.)	TOMATE (TOMATO)	
Ya hay pescado en el plancha. (There is already fish on the griddle.)	PESCADO (FISH)	
Ya hay naranjas en el frutero. (There are already oranges in the fruit bowl.)	NARANJAS (ORANGES)	
Negative sentences	**Probe**	**Coherent continuation**
No hay baterías en el cajón. (There are no batteries in the drawer.)	BATERÍAS (BATTERIES)	Sale a comprar baterías para el despertador. (He/She goes out to buy batteries for the alarm clock.)
No tienen toalla en el baño. (They don't have a towel in	TOALLA (TOWEL)	Después de ducharse no tiene con que secarse.

the bathroom.)		(After the shower, he/she has nothing to dry his/her body.)
No hay móviles en la tienda. (There are no cellphones in the store.)	MÓVILES (CELLPHONES)	Tiene que ir a otra tienda para comprar un móvil. (He/She has to go to another store to buy a cellphone.)
No tienen helados en la cocina. (They don't have icecreams in the kitchen.)	HELADOS (ICECREAMS)	El niño le pide a su padre que le compre helado. (The boy asks his father to buy him icecream.)
No tienen abrigo en el perchero. (They don't have a coat on the rack.)	ABRIGO (COAT)	Porque la madre dobló el abrigo y lo puso en el armario. (Because the mother folded the coat and put it in the closet.)
No hay monos en la jaula. (There are no monkeys in the cage.)	MONOS (MONKEYS)	Porque los monos están jugando en el árbol. (Because the monkeys are playing in the tree.)
No hay tarjetas en su billetera. (There are no cards in his/her wallet.)	TARJETAS (CARDS)	Tiene que pagar el almuerzo con efectivo. (He/She has to pay for lunch with cash.)
No hay teléfono en su oficina. (There is no telephone in his/her office.)	TELÉFONO (TELEPHONE)	Entonces llama a sus clientes con su móvil. (So he/she calls his/her customers with his/her cellphone.)
No tienen zumos en la cafetería. (They don't have juices in the cafeteria.)	ZUMOS (JUICES)	Tiene que pedir café en lugar de zumo. (He/She has to ask for coffee instead of juice.)
No tiene llaves en su bolsillo. (He/She doesn't have keys in his/her pocket.)	LLAVES (KEYS)	Entonces toca el timbre para que le abran la puerta. (So he/she rings the bell to open the door.)
No tiene monedas en su billetera. (He/She doesn't have coins in his/her wallet.)	MONEDAS (COINS)	Tiene que compra el billete de tranvía con la tarjeta. (He/She has to buy the tram ticket with the card.)
No hay pollo en el microondas. (There's no chicken in the microwave.)	POLLO (CHICKEN)	Porque la madre sacó el pollo del microondas hace unos minutos. (Because the mother took the chicken out of the microwave a few minutes ago.)

No tienen frutas en el pastel. (They don't have fruits on the cake.)	FRUTAS (FRUITS)	El pastel solo está hecho de chocolate y crema. (The cake is only made of chocolate and cream.)
No tienen galletas en la bolsa. (They don't have cookies in the bag.)	GALLETAS (COOKIES)	Porque ayer no compró galletas en el mercado. (Because he/she didn't buy cookies at the market yesterday.)
No hay tenedor en la bandeja. (There is no fork on the tray.)	TENEDOR (FORK)	Entonces le pide al camarero que le traiga un tenedor. (So he/she asks the waiter to bring him/her a fork.)
No tienen lirios en la floristería. (They don't have lilies at the florist.)	LIRIOS (LILIES)	Entonces compra un ramo de rosas para su novia. (So he buys a bouquet of roses for his girlfriend.)
No hay sábana en su cama. (There is no bedsheet on his/her bed.)	SÁBANA (BEDSHEET)	Entonces la madre extiende una sábana sobre su cama. (So the mother spreads a bedsheet over his/her bed.)
No hay papel en la impresora. (There is no paper in the printer.)	PAPEL (PAPER)	Entonces puso papel en la impresora para poder imprimir. (So he/she puts paper in the printer to be able to print.)
No hay alcohol en el botiquín. (There is no alcohol in the medicine cabinet.)	ALCOHOL (ALCOHOL)	Irá a la farmacia a comprar alcohol. (He/she will go to the pharmacy to buy alcohol.)
No tienen perros en el patio. (They don't have dogs in the yard.)	PERROS (DOGS)	Los perros están en el sofá junto a su dueño. (The dogs are on the couch next to their owner.)
No tienen suciedad en la ventanilla. (They don't have dirt on the window.)	SUCIEDAD (DIRT)	Porque ella limpió la ventanilla hace un momento. (Because he/she cleaned the window just now.)
No hay aceite en la sartén. (There is no oil in the pan.)	ACEITE (OIL)	Echa aceite en la sartén para freir el bistec. (He/She pours oil into the pan to fry the steak.)
No tiene sudor en su frente. (He/She doesn't have sweat on his/her forehead.)	SUDOR (SWEAT)	Porque lo acaba de limpiar con una servilleta. (Because he/she just wiped it with a

		napkin.)
No hay refresco en los vasos. (There is no soda in the glasses.)	REFRESCO (SODA)	Porque a los invitados les gusta beber vino. (Because the guests like to drink wine.)
Negative sentences	**Probe**	**Incoherent continuation**
No hay manzanas en la nevera. (There are no apples in the fridge.)	MANZANAS (APPLES)	Saca una manzana de la nevera y se la come. (He/She takes an apple out of the fridge and eats it.)
No tienen tinta en la impresora. (They don't have ink in the printer.)	TINTA (INK)	La secretaria abre el archivo y lo imprime. (The secretary opens the file and prints it.)
No hay pulseras en la joyería. (There are no bracelets in the jewelry store.)	PULSERAS (BRACELETS)	Compra una pulsera para su amiga en la joyería. (He/She buys a bracelet for his/her friend at the jewelry store.)
No tienen tiritas en el botiquín. (They don't have plasters in the medicine cabinet.)	TIRITAS (PLASTERS)	Toma una tirita y se la coloca en el dedo. (He/She takes a plaster and puts it on his/her finger.)
No tiene vestidos en el armario. (She doesn't have dresses in the closet.)	VESTIDOS (DRESSES)	Elige un bonito vestido del armario para la fiesta. (She picks a nice dress from the closet for the party.)
No tienen mantas en el sofá. (They don't have blankets on the couch.)	MANTAS (BLANKETS)	Se tapa con una manta ya que siente frío. (He/She covers himself/herself with a blanket since he/she feels cold.)
No tienen escoba para el piso. (They don't have a broom for the floor.)	ESCOBA (BROOM)	Ella toma la escoba y barre el piso. (He/She takes the broom and sweeps the floor.)
No tiene pañuelo en su bolso. (He/She doesn't have a handkerchief in her bag.)	PAÑUELO (HANKERCHIEF)	Usa el pañuelo para limpiarse la mano. (He/She uses the handkerchief to wipe his/her hand.)
No hay camisas en el armario. (There are no shirts in the	CAMISAS (SHIRTS)	Elige una camisa blanca para combinar con sus pantalones. (He selects a white shirt to match

closet.)		his pants.)
No hay cojines en el sofá. (There are no cushions on the sofa.)	COJINES (CUSHIONS)	Se apoya en los cojines para sentirse cómodo. (He/She leans on the cushions to feel comfortable.)
No tienen carteles en el pasillo. (They don't have posters in the hallway.)	CARTELES (POSTERS)	Los carteles anuncian las nuevas películas. (The posters advertise the new movies.)
No hay peine en el tocador. (There is no comb on the dresser.)	PEINE (COMB)	Se peina con el peine antes de salir por la mañana. (He/She combs his/her hair before going out in the morning.)
No tienen bebidas en el maletero. (They don't have drinks in the trunk.)	BEBIDAS (DRINKS)	Cogen las bebidas del coche para tomarlas en la barbacoa. (They take the drinks from the car to have them on the barbecue.)
No tienen roturas en la ventanilla. (They don't have cracks on the window.)	ROTURAS (CRACKS)	Llamará a un mecánico para reparar la ventanilla. (He/She will call a mechanic to repair the window.)
No tienen cerveza en los vasos. (They don't have beer in the glasses.)	CERVEZA (BEER)	Bebe varios vasos de cerveza con sus amigos. (He/She drinks several glasses of beer with his/her friends.)
No hay corbatas para el traje. (There are no ties for the suit.)	CORBATAS (TIES)	Se pone una corbata gris para combinar con su traje. (He puts on a gray tie to match his suit.)
No tienen tijeras en el cajón. (They don't have scissors in the drawer.)	TIJERAS (SCISSORS)	Saca las tijeras y corta la cuerda con ellas. (He/She takes out the scissors and cut the string with them.)
No tienen radio en el estante. (They don't have radios on the shelf.)	RADIO (RADIO)	Enciende la radio para escuchar el programa. (He/She turns on the radio to listen to the program.)
No tienen anillos en la joyería. (They don't have rings in the jewelry store.)	ANILLOS (RINGS)	Compra un anillo de oro para su prometida. (He buys a gold ring for his fiancee.)

No hay sandía en la cocina. (There is no watermelon in the kitchen.)	SANDÍA (WATERMELON)	Corta la sandía en pedazos y los comparte con su familia. (He/She cuts the watermelon into pieces and shares them with his/her family.)
No hay equipaje en el maletero. (There is no luggage is in the trunk.)	EQUIPAJE (LUGGAGE)	Llevará el equipaje al aeropuerto por su esposa. (He will take the luggage to the airport for his wife.)
No hay velas en el pastel. (There are no candles on the cake.)	VELAS (CANDLES)	Enciende las velas y canta la canción de cumpleaños. (He/She lights the candles and sings the birthday song.)
No hay etiqueta para el traje. (There is no tag for the suit.)	ETIQUETA (TAG)	La etiqueta está atada al traje con un hilo negro. (The tag is tied to the suit with a black thread.)
No hay cuchara en la bandeja. (There is no spoon on the tray.)	CUCHARA (SPOON)	Se comerá la sopa con la cuchara. (He/She will eat the soup with the spoon.)
Negative sentences	**Probe**	**No continuation**
No hay crema en el frasco. (There is no cream in the jar.)	CREMA (CREAM)	
No tiene colcha en su cama. (He/She doesn't have a quilt on his/her bed.)	COLCHA (QUILT)	
No hay botas en el estante. (There are no boots on the shelf.)	BOTAS (BOOTS)	
No tienen fideos en la olla. (They don't have noodles in the pot.)	FIDEOS (NOODLES)	
No tienen setas en la cesta. (They don't have mushrooms in the basket.)	SETAS (MUSHROOMS)	
No tienen jamón en la pizza. (They don't have ham on the pizza.)	JAMÓN (HAM)	

No tienen candado en la puerta. (They don't have padlock on the door.)	CANDADO (PADLOCK)	
No hay champú en la peluquería. (There is no shampoo in the salon.)	CHAMPÚ (SHAMPOO)	
No tienen peras en la mesa. (They don't have pears on the table.)	PERAS (PEARS)	
No hay gatos en el patio. (There are no cats in the yard.)	GATOS (CATS)	
No tienen revistas en la estantería. (They don't have magazines on the shelf.)	REVISTAS (MAGAZINES)	
No hay teclado en el escritorio. (There is no keyboard on the desk.)	TECLADO (KEYBOARD)	
No hay chicles en su bolsillo. (There are no gums in his/her pocket.)	CHICLES (GUMS)	
No hay pudines en la cafetería. (There are no puddings in the cafeteria.)	PUDINES (PUDDINGS)	
No hay blusas en la lavadora. (There are no blouses in the washing machine.)	BLUSAS (BLOUSES)	
No hay maceta en el balcón. (There is no flowerpot on the balcony.)	MACETA (FLOWERPOT)	
No hay dulces en la caja. (There are no sweets in the box.)	DULCES (SWEETS)	
No hay espresso en las tazas. (There is no espresso in the	ESPRESSO (ESPRESSO)	

cups.)		
No hay bistec en el plato. (There is no steak on the plate.)	BISTEC (STEAK)	
No hay queso en la pasta. (There is no cheese in the pasta.)	QUESO (CHEESE)	
No hay señales en el pasillo. (There are no signs in the hall.)	SEÑALES (SIGNS)	
No tienen gambas en el microondas. (They don't have shrimps in the microwave.)	GAMBAS (SHRIMPS)	
No hay ensalada en el tazón. (There's no salad in the bowl.)	ENSALADA (SALAD)	
No tienen perfume en el tocador. (They don't have perfume on the dresser.)	PERFUME (PERFUME)	
No hay bufanda en la percha. (There is no scarf on the hanger.)	BUFANDA (SCARF)	
No tienen loros en la jaula. (They don't have parrots in the cage.)	LOROS (PARROTS)	
No hay pijamas en la lavadora. (There are no pajamas in the washing machine.)	PIJAMAS (PAJAMAS)	
No tienen extintor en el edificio. (They don't have extinguisher in the building.)	EXTINTOR (EXTINGUISHER)	
No hay regalos en la caja. (There are noy gifts in the box.)	REGALOS (GIFTS)	

No tienen leche en las tazas. (They don't have milk in the cups.)	LECHE (MILK)	
No hay huesos en el plato. (There are no bones on the plate.)	HUESOS (BONES)	
No tienen cebolla en la pasta. (They don't have onion in the pasta.)	CEBOLLA (ONION)	
No tiene brócoli en el tazón. (He/She doesn't have broccoli in the bowl.)	BRÓCOLI (BROCCOLI)	
No hay dinero en su bolso. (There is no money in her purse.)	DINERO (MONEY)	
No tiene libros en su oficina. (He/She doesn't have books in his/her office.)	LIBROS (BOOKS)	
No hay fregona para el piso. (There is no mop for the floor.)	FREGONA (MOP)	
No hay cinturón para la falda. (There is no belt for the skirt.)	CINTURÓN (BELT)	
No hay lápices en el estuche. (There are no pencils in the case.)	LÁPICES (PENCILS)	
No hay folletos en el buzón. (There are no brochures in the mailbox.)	FOLLETOS (BROCHURES)	
No tienen lechuga para el sándwich. (They don't have lettuce for the sandwich.)	LECHUGA (LETTUCE)	
No hay tocino en la sartén. (There is no bacon in the pan.)	TOCINO (BACON)	
No tiene botones en el suéter.	BOTONES (BUTTONS)	

(He/She doesn't have buttons on the sweater.)		
No hay nueces en el yogurt. (There are no nuts in the yogurt.)	NUECES (NUTS)	
No hay pesas en el gimnasio. (There are no dumbbells in the gym.)	PESAS (DUMBBELLS)	
No hay perlas para el sombrero. (There are no pearls for the hat.)	PERLAS (PEARLS)	
No tienen mayonesa en la hamburguesa. (They don't have mayonnaise on the burger.)	MAYONESA (MAYONNAISE)	
No hay carne en la plancha. (There is no meat on the grill.)	CARNE (MEAT)	
No hay ciruelas en el frutero. (There are no plums in the fruit bowl.)	CIRUELAS (PLUMS)	
No tiene azúcar en el frasco. (He/She doesn't have sugar in the jar.)	AZÚCAR (SUGAR)	
No tienen papayas en la nevera. (They don't have papayas in the fridge.)	PAPAYAS (PAPAYAS)	
No hay jabón en el baño. (There is no soap in the bathroom.)	JABÓN (SOAP)	
No hay arroz en la olla. (There is no rice in the pot.)	ARROZ (RICE)	
No hay mangos en la cesta. (There are no mangos in the basket.)	MANGOS (MANGOS)	
No hay verdura en la pizza. (There is no vegetable on the pizza.)	VERDURA (VEGETABLE)	

No tienen cámaras en la tienda. (They already have cameras in store.)	CÁMARAS (CAMERAS)	
No hay timbre en la puerta. (There is no bell at the door.)	TIMBRE (BELL)	
No tienen secador en la peluquería. (They don't have hairdryer in the hair salon.)	SECADOR (HAIRDRYER)	
No hay botella en la mesa. (There is no bottle on the table.)	BOTELLA (BOTTLE)	
No hay novelas en la estantería. (There are no novels on the shelf.)	NOVELAS (NOVELS)	
No tienen carpeta en el escritorio. (They don't have folder on the desk.)	CARPETA (FOLDER)	
No tienen tirante para la falda. (They don't have strap for the skirt.)	TIRANTE (STRAP)	
No hay limones en la bolsa. (There are no lemons in the bag.)	LIMONES (LEMONS)	
No tienen reglas en el estuche. (They don't have rulers in the case.)	REGLAS (RULERS)	
No hay cartas en el buzón. (There are no letters in the mailbox.)	CARTAS (LETTERS)	
No tienen huevos para el sándwich. (They don't have eggs for the sandwich.)	HUEVOS (EGGS)	
No tiene broche en el suéter. (He/She doesn't have	BROCHE (BROOCH)	

brooch on his/her sweater.)		
No hay cereal en el yogurt. (There is no cereal in the yogurt.)	CEREAL (CEREAL)	
No hay plumas para el sombrero. (There are no feathers for the hat.)	PLUMAS (FEATHERS)	
No hay rosas en la floristería. (There are no roses at the florist.)	ROSAS (ROSES)	
No hay tomate en la hamburguesa. (There is no tomato in the burger.)	TOMATE (TOMATO)	
No hay pescado en el plancha. (There is no fish on the griddle.)	PESCADO (FISH)	
No hay naranjas en el frutero. (There are no oranges in the fruit bowl.)	NARANJAS (ORANGES)	

Filler sentences in Spanish and their English translations		
Affirmative sentences	**O-modified**	**Coherent continuation**
Ya hay columpios en la guardería. (There are already swings in the nursery.)	BALANCINES (SEESAWS)	Los niños juegan en los columpios después de la clase. (The children play on the swings after class.)
Ya hay cabras en la granja. (There are already goats on the farm.)	PAVOS (TURKEYS)	El granjero alimenta a las cabras todos los días. (The farmer feeds the goats every day.)
Ya hay barcos en la costa. (There are already ships on the coast.)	YATES (YACHTS)	Uno de los barcos llevará a los pasajeros a la otra isla. (One of the boats will take the

		passengers to the other island.)
Ya hay vacas en el prado. (There are already cows in the meadow.)	OVEJAS (SHEEP)	Las vacas están comiendo hierba en el prado. (The cows are eating grass on the meadow.)
Ya tienen jugadores en el estadio. (They already have players in the stadium.)	ENTRENADORES (COACHES)	Los jugadores se están entrenándo para el partido. (The players are training for the game.)
Ya hay cuadros en la exposición. (There are already paintings in the exhibition.)	FOTOS (PHOTOS)	Los cuadros son obra de un pintor local. (The paintings are the work of a local painter.)
Affirmative sentences	**O-modified**	**Incoherent continuation**
Ya tienen bancos en el parque. (They already have benches in the park.)	PABELLONES (PAVILIONS)	La gente no tiene lugar para sentarse en el parque. (People have no place to sit in the park.)
Ya hay cuervos en el nido. (There are already crows in the nest.)	GOLONDRINAS (SWALLOWS)	Todos los cuervos están volando en el cielo. (All the crows are flying in the sky.)
Ya tienen puente sobre el río. (They already have a bridge over the river.)	BUQUE (SHIP)	De modo que deben cruzar el río en barca. (So they must cross the river by boat.)
Ya tienen ascensores en el edificio. (They already have elevators in the building.)	PILARES (PILLARS)	Por tanto, tiene que subir las escaleras hasta su casa. (Therefore, he/she has to climb the stairs to his/her home.)
Ya tienen pasajeros en el tren. (They already have passengers on the train.)	ESTUDIANTES (STUDENTS)	Todos los pasajeros están esperando en la plataforma. (All the passengers are waiting on the platform.)
Ya hay actores en el escenario. (There are already actors on the stage.)	VIOLINISTAS (VIOLINISTS)	Todos los actores están entre bambalinas esperando su entrada. (All the actors are behind the scenes waiting for their entrance.)
Affirmative sentences	**O-modified**	**No continuation**

Ya hay cortina en la habitación. (There is already a curtain in the room.)	TELEVISIÓN (TELEVISION)	
Ya tienen recepcionistas en la entrada. (They already have receptionists at the entrance.)	POLICIAS (POLICE)	
Ya hay biblioteca en la ciudad. (There is already a library in the city.)	PUERTO (PORT)	
Ya tienen bicicletas en el tranvía. (They already have bikes on the tram.)	MOTOS (MOTORCYCLES)	
Ya hay arboles en la colina. (There are already trees on the hill.)	CACTUS (CACTUS)	
Ya tienen cajeros en el mercado. (They already have ATMs in the market.)	CLIENTES (CUSTOMERS)	
Ya tienen antenas en el tejado. (They already have antennas on the roof.)	CHIMENEA (CHIMNEY)	
Ya hay hojas en el árbol. (There are already leaves on the tree.)	FLORES (FLOWERS)	
Ya tienen abejas en las flores. (They already have bees on the flowers.)	LIBÉLULAS (DRAGONFLIES)	
Ya hay fotos en la pared. (There are already pictures on the wall.)	PINTURAS (PAINTINGS)	
Ya hay pimientos en el huerto. (There are already peppers in the garden.)	CALABAZAS (PUMPKINS)	

Ya hay fresas en el postre. (There are already strawberries in the dessert.)	PISTACHIOS (PISTACHIOS)	
Ya tienen zapatillas por el suelo. (They already have slippers on the floor.)	SANDALIAS (SANDALS)	
Ya hay camareros en el restaurante. (There are already waiters in the restaurant.)	CONSUMIDORES (CONSUMERS)	
Ya hay banderas en el palacio. (There are already flags in the palace.)	ANTIGÜEDADES (ANTIQUES)	
Ya tienen gato en la escalera. (They already have a cat on the stair.)	PERRO (DOG)	
Ya hay estufa en el dormitorio. (There is already a heater in the bedroom.)	VENTILADOR (FAN)	
Ya tienen espejos en la casa. (They already have mirrors in the house.)	GANCHOS (HOOKS)	
Ya hay turistas en el palacio. (There are already tourists in the palace.)	GUÍAS (GUIDES)	
Ya tienen alarma en la escalera. (They already have an alarm in the stairway.)	PASAMANOS (HANDRAILS)	
Ya tienen toboganes en la guardería. (They already have slides in the nursery.)	TIOVIVO (CAROUSEL)	
Ya hay aseos en el mercado. (There are already toilets on the market.)	PROBADORES (FITTING ROOMS)	

Ya hay delfines en la costa. (There are already dolphins on the coast.)	CANGREJOS (CRABS)	
Ya tienen peces en el río. (They already have fish in the river.)	COCODRILOS (CROCODILES)	
Negative sentences	**O-modified**	**Coherent continuation**
No hay parada en la avenida. (There is no stop on the avenue.)	GASOLINERA (GAS STATION)	Tienen que ir a otra calle para esperar la guagua. (They have to go to another street to wait for the bus.)
No tienen librería en el pueblo. (They don't have a bookstore in town.)	PIZZERÍA (PIZZERIA)	La gente del pueblo suele comprar libros en Amazon. (The townspeople often buy books on Amazon.)
No tiene bocadillo en su mochila. (He/She has no sandwich in his/her backpack.)	HAMBURGUESA (HAMBURGER)	Porque olvidó coger el bocadillo al salir de casa. (Because he/she forgot to take the sandwich when he/she left home.)
No hay azafrán para la paella. (There is no saffron for paella.)	SAL (SALT)	Irá al mercado a comprar un poco de azafrán para la paella. (He/She will go to the market to buy some saffron for the paella.)
No hay peatones en el cruce. (There are no pedestrians at the crossing.)	HOMBRES (MEN)	Entonces el coche pasa el cruce sin detenerse. (So the car passes the crossing without stopping.)
Negative sentences	**O-modified**	**Incoherent continuation**
No hay sombrillas en la playa. (There are no beach umbrellas on the beach.)	PARAGUAS (UMBRELLAS)	Los turistas se acuestan bajo la sombrilla. (The tourists lie under the beach umbrella.)
No tienen pacientes en la clínica. (They don't have patients in the clinic.)	ENFERMERAS (NURSES)	Los doctores reciben a muchos pacientes. (The doctors receive many patients.)
No hay mariscos en la sopa. (There is no shellfish in the soup.)	FRIJOLES (BEANS)	Coge con la cuchara un rico marisco en la sopa. (He/She takes a delicious shellfish in the soup with the

		spoon.)
No hay cicatriz en su piel. (There is no scar on his skin.)	ARRUGA (WRINKLE)	Se hizo la cicatriz jugando con un cuchillo. (He had the scar when playing with a knife.)
No hay piscina en la universidad. (There is no swimming pool at the university.)	PATIO (PLAYGROUND)	El profesor va a nadar a la piscina todas las semanas. (The teacher goes to swim in the swimming pool every week.)
No tienen camiones en la fábrica. (They don't have trucks at the factory.)	GRÚAS (CRANES)	Los trabajadores están cargando mercancías en los camiones. (The workers are loading goods onto the trucks.)
No tienen lápidas en el museo. (They don't have tombstones in the museum.)	MOMIAS (MUMMIES)	Los turistas están leyendo los epitafios en las lápidas. (The tourists are reading the epitaphs on the tombstones.)
Negative sentences	**O-modified**	**No continuation**
No hay ambulancias en el hospital. (There are no ambulances at the hospital.)	JERINGAS (SYRINGES)	
No tienen auditorio en la escuela. (They don't have auditorium at school.)	CANTINA (CANTEEN)	
No hay panadería en el barrio. (There is no bakery in the neighborhood.)	DULCERÍA (CANDY SHOP)	
No tienen leones en el zoológico. (They don't have lions at the zoo.)	VENADOS (DEERS)	
No hay palomas en la plaza. (There are no pigeons in the square.)	GAVIOTAS (SEAGULLS)	
No tienen nieve en la montaña. (They have no snow on the mountain.)	ARENA (SAND)	

No hay chocolate en el pan. (There is no chocolate in the bread.)	MANTEQUILLA (BUTTER)	
No tienen sierras en el taller. (They do not have saws in the workshop.)	MARTILLOS (HAMMERS)	
No tienen costillas en el horno. (They don't have ribs in the oven.)	ALBÓNDIGAS (MEATBALLS)	
No tienen paralelas en el gimnasio. (They don’t have parallel bars in the gym.)	PESAS (DUMBBELLS)	
No tienen diamantes en el joyero. (They don't have diamonds in the jewelry box.)	RUBÍES (RUBIES)	
No hay mojo en el bote. (There is no mojo in the pot.)	JUGO (JUICE)	
No hay antenas en el observatorio. (There are no antennas at the observatory.)	MICROSCOPIOS (MICROSCOPES)	
No hay zorros en la cueva. (There are no foxes in the cave.)	CONEJOS (RABBITS)	
No tienen ratones en el poblado. (They don't have mice in the village.)	TORTUGAS (TURTLES)	
No hay tigres en el bosque. (There are no tigers in the forest.)	ARDILLAS (SQUIRRELS)	
No hay coches en la calle. (There are no cars on the street.)	TRACTORES (TRACTORS)	
No hay luna en el cielo. (There is no moon in the sky.)	SOL (SUN)	

No hay cantante en el escenario. (There is no singer on stage.)	PIANISTA (PIANIST)	
No tienen público en el estadio. (They don't have audience in the stadium.)	PERIODISTA (JOURNALIST)	
No tienen cerdos en la granja. (They don't have pigs on the farm.)	PATOS (DUCKS)	
No tienen lámparas en la habitación. (They don't have lamps in the room.)	ENCHUFES (PLUGS)	
No tienen caballos en el prado. (They don't have horses in the meadow.)	BURROS (DONKEYS)	
No hay pájaros en el tejado. (There are no birds on the roof.)	TUBERÍAS (PIPELINES)	
Affirmative sentences	**P-identical**	**No continuation**
Ya hay sillas en la sala. (There are already chairs in the room.)	SALA (ROOM)	
Ya tienen calcetines por el suelo. (They already have socks on the floor.)	SUELO (FLOOR)	
Ya hay mesillas en el dormitorio. (There are already nightstands in the bedroom.)	DORMITORIO (BEDROOM)	
Ya tienen alfombras en su casa. (They already have carpets in their house.)	CASA (HOUSE)	
Ya hay gorriones en el nido. (There are already sparrows	NIDO (NEST)	

in the nest.)		
Ya tienen molinos en la colina. (They already have mills on the hill.)	COLINA (HILL)	
Ya hay médicos en la clínica. (There are already doctors in the clinic.)	CLÍNICA (CLINIC)	
Ya tienen camillas en el hospital. (They already have stretchers at the hospital.)	HOSPITAL (HOSPITAL)	
Ya hay ramas en el árbol. (There are already branches on the tree.)	ÁRBOL (TREE)	
Ya hay mariposas en las flores. (There are already butterflies on the flowers.)	FLORES (FLOWERS)	
Ya tienen reloj en la pared. (They already have a clock on the wall.)	PARED (WALL)	
Ya tienen toldo en el balcón. (They already have an awning on the balcony.)	BALCÓN (BALCONY)	
Affirmative sentences	**P-modified**	**No continuation**
Ya hay telescopios en el observatorio. (There are already telescopes at the observatory.)	CAMPUS (CAMPUS)	
Ya tienen almacén en la fábrica. (They already have a warehouse in the factory.)	EMPRESA (COMPANY)	
Ya tienen serpientes en el poblado. (They already have snakes in the village.)	ARBUSTO (BUSH)	

Ya hay ancianos en la calle. (There are already elders on the street.)	ESTACIÓN (STATION)	
Ya tienen teleférico en la montaña. (They already have a cable car on the mountain.)	CAMPO (FIELD)	
Ya hay guardias en la entrada. (There are already guards at the entrance.)	SALIDA (DEPARTURE)	
Ya tienen aeropuerto en la ciudad. (They already have an airport in the city.)	BASE (BASE)	
Ya hay conductor en el tranvía. (There is already a driver on the tram.)	METRO (METRO)	
Ya hay mermelada en el pan. (There is already jam on the bread.)	TOSTADA (TOAST)	
Ya hay medicinas en la alacena. (There are already medicines in the cupboard.)	GAVETA (DRAWER)	
Ya hay papas en el horno. (There are already potatoes in the oven.)	MICROONDAS (MICROWAVE)	
Ya tienen bolígrafo en la mochila. (They already have a pen in the backpack.)	CARTERA (HANDBAG)	
Negative sentences	**P-identical**	**No continuation**
No hay osos en la cueva. (There are no bears in the cave.)	CUEVA (CAVE)	
No hay nubes en el cielo. (There are no clouds in the sky.)	CIELO (SKY)	

No hay semáforo en el cruce. (There is no traffic light at the crossing.)	CRUCE (CROSSING)	
No tienen lobos en el bosque. (They don't have wolves in the forest.)	BOSQUE (FOREST)	
No hay zapatería en el pueblo. (There is no shoe store in town.)	PUEBLO (TOWN)	
No tienen frutería en el barrio. (They don't have a greengrocer in the neighborhood.)	BARRIO (NEIGHBORHOOD)	
No hay pingüinos en el zoológico. (There are no penguins in the zoo.)	ZOOLÓGICO (ZOO)	
No tienen bailarinas en el teatro. (They don't have dancers in the theater.)	TEATRO (THEATER)	
No tienen repollos en el huerto. (They don't have cabbages in the garden.)	HUERTO (GARDEN)	
No tienen arándanos en el postre. (They don't have blueberries in the dessert.)	POSTRE (DESSERT)	
No tienen aceitunas en la ensalada. (They don't have olives in the salad.)	ENSALADA (SALAD)	
No hay gofio en el bote. (There is no gofio in the jar.)	BOTE (JAR)	
Negative sentences	**P-modified**	**No continuation**

No tienen estatuas en el museo. (They don't have statues in the museum.)	GALERÍA (GALLERY)	
No hay cocineros en el restaurante. (There are no cooks in the restaurant.)	HOTEL (HOTEL)	
No tienen maletas en el tren. (They don't have suitcases on the train.)	AUTOBÚS (BUS)	
No hay escultura en el campus. (There is no sculpture in the campus.)	JARDÍN (YARD)	
No hay estanques en el parque. (There are no ponds in the park.)	FINCA (FARM)	
No tienen salvavidas en la playa. (They don't have lifeguards on the beach.)	YATE (YACHT)	
No tienen guaguas en el garaje. (They don't have buses in the garage.)	ESTACIÓN (STATION)	
No hay laboratorio en la escuela. (There is no laboratory at the school.)	ACADEMIA (ACADEMY)	
No tienen calamares en la paella. (They don't have calamari in the paella.)	SOPA (SOUP)	
No tiene pelo en su frente. (She doesn’t have hair on her forehead.)	CARA (FACE)	
No hay collares en el joyero. (There are no necklaces in the jewelry box.)	TOCADOR (DRESSER)	

No tiene lunares en su piel. (He/She has no moles on his/her skin.)	BRAZO (ARM)	

Note: O-modified means a probe word that is semantically related to the object noun in the filler sentence, **P-identical** means a probe word that is the place noun appearing in the filler sentence and **P-modified** means a probe word that is semantically related to the place noun in the filler sentence.

Appendix 4

Pre-test questionnaires of coherence judgment for Experiment 3

Questionnaire 1

Instruction

En este cuestionario, decida si la segunda oración es una continuación coherente de la primera oración. Por ejemplo, la primera oración es "*Ya hay pantalones en la lavadora*". Si la segunda oración es "*Los pantalones están muy sucios*", la respuesta debe ser **SI**, y debe escribir "**5**" con el teclado. Si la segunda oración es "*La lavadora está vacía ahora*", la respuesta debe ser **NO**, y debe escribir "**6**" con el teclado.

(**English translation**: In this questionnaire, you should decide whether the second sentence is a sensible continuation of the first sentence. For example, the first sentence is "*There are already pants in the washing machine*". If the second sentence is "*The pants are very dirty*", the answer should be **YES**, and you must type "**5**" with the keyboard. If the second sentence is "*The washing machine is empty now*", the answer should be **NO**, and you must type "**6**" with the keyboard.)

Número	La primera oración	La segunda oración	SÍ or NO
Ejemplo	**No hay ciclistas en la salida.**	**Los ciclistas van a iniciar la competición.**	**6**
1	No tiene pañuelo en su bolso.	Usa el pañuelo para limpiarse la mano.	
2	Ya tiene sudor en su frente.	Porque lo acaba de limpiar con una servilleta.	
3	No hay aceite en la sartén.	Echa aceite en la sartén para freir el bistec.	
4	Ya tienen bebidas en el maletero.	Cogen las bebidas del coche para tomarlas en la barbacoa.	
5	Ya tienen frutas en el pastel.	El pastel solo está hecho de chocolate y crema.	
6	Ya tienen perros en el patio.	Los perros están en el sofá junto a su dueño.	
7	No tienen cerveza en los vasos.	Bebe varios vasos de cerveza con sus amigos.	
8	No tienen lirios en la floristería.	Entonces compra un ramo de rosas para su novia.	
9	No hay papel en la impresora.	Entonces puso papel en la impresora para poder imprimir.	
10	Ya hay etiqueta para el traje.	La etiqueta está atada al traje con un hilo negro.	
11	No tienen zumos en la cafetería.	Pide una taza de café en lugar de zumo.	
12	Ya tienen mantas en el sofá.	Se tapa con una manta ya que siente frío.	
13	No tiene llaves en su bolsillo.	Entonces toca el timbre para que le abran la puerta.	
14	Ya hay manzanas en la nevera.	Saca una manzana de la nevera y se la come.	
15	Ya hay sandía en la cocina.	Corta la sandía en pedazos y los comparte con su familia.	
16	Ya tienen toalla en el baño.	Después de ducharse no tiene con que secarse.	
17	Ya tiene vestidos en el armario.	Elige un bonito vestido del armario para la fiesta.	
18	No hay camisas en el armario.	Elige una camisa blanca para combinar con sus pantalones.	
19	No hay cojines en el sofá.	Se apoya en los cojines para sentirse cómodo.	

20	No tienen tiritas en el botiquín.	Toma una tirita y se la coloca en el dedo.	
21	No hay equipaje en el maletero.	Llevará el equipaje al aeropuerto por su esposa.	
22	No tienen radio en el estante.	Enciende la radio para escuchar el programa.	
23	Ya hay monos en la jaula.	Porque los monos están jugando en el árbol.	
24	No tienen escoba para el piso.	Ella toma la escoba y barre el piso.	
25	Ya hay alcohol en el botiquín.	Irá a la farmacia a comprar alcohol.	
26	No hay tenedor en la bandeja.	Entonces le pide al camarero que le traiga un tenedor.	
27	Ya tienen abrigo en el perchero.	Porque la madre dobló el abrigo y lo puso en el armario.	
28	No tienen tijeras en el cajón.	Saca las tijeras y corta la cuerda con ellas.	
29	Ya tienen anillos en la joyería.	Compra un anillo de oro para su prometida.	
30	Ya hay peine en el tocador.	Se peina con el peine antes de salir por la mañana.	
31	No tienen suciedad en la ventanilla.	Porque ella limpió la ventanilla hace un momento.	
32	Ya hay refresco en los vasos.	Porque a los invitados les gusta beber vino.	
33	Ya tiene monedas en su billetera.	Tiene que compra el billete de tranvía con la tarjeta.	
34	Ya hay baterías en el cajón.	Sale a comprar baterías para el despertador.	
35	No hay corbatas para el traje.	Se pone una corbata gris para combinar con su traje.	
36	No hay sábana en su cama.	Entonces la madre extiende una sábana sobre su cama.	
37	No hay velas en el pastel.	Enciende las velas y canta la canción de cumpleaños.	
38	No hay pulseras en la joyería.	Compra una pulsera para su amiga en la joyería.	
39	Ya hay pollo en el microondas.	Porque la madre sacó el pollo del microondas hace unos minutos.	
40	Ya tienen tinta en la impresora.	La secretaria abre el archivo y lo imprime.	

41	Ya hay cuchara en la bandeja.	Se comerá la sopa con la cuchara.	
42	Ya tienen galletas en la bolsa.	Porque ayer no compró galletas en el mercado.	
43	No hay móviles en la tienda.	Tiene que ir a otra tienda para comprar un móvil.	
44	Ya tienen carteles en el pasillo.	Los carteles anuncian las nuevas películas.	
45	No tienen helados en la cocina.	El niño le pide a su padre que le compre helado.	
46	No hay teléfono en su oficina.	Entonces llama a sus clientes con su móvil.	
47	No hay tarjetas en su billetera.	Tiene que pagar el almuerzo con efectivo.	
48	Ya tienen roturas en la ventanilla.	Llamará a un mecánico para reparar la ventanilla.	

Questionnaire 2

Instruction

En este cuestionario, decida si la segunda oración es una continuación coherente de la primera oración. Por ejemplo, la primera oración es "*Ya hay pantalones en la lavadora*". Si la segunda oración es "*Los pantalones están muy sucios*", la respuesta debe ser **SI**, y debe escribir "**5**" con el teclado. Si la segunda oración es "*La lavadora está vacía ahora*", la respuesta debe ser **NO**, y debe escribir "**6**" con el teclado.

(**English translation**: In this questionnaire, you should decide whether the second sentence is a sensible continuation of the first sentence. For example, the first sentence is "*There are already pants in the washing machine*". If the second sentence is "*The pants are very dirty*", the answer should be **YES**, and you must type "**5**" with the keyboard. If the second sentence is "*The washing machine is empty now*", the answer should be **NO**, and you must type "**6**" with the keyboard.)

Número	La primera oración	La segunda oración	SÍ or NO
Ejemplo	**No hay ciclistas en la salida.**	**Los ciclistas van a iniciar la competición.**	**6**
1	No hay etiqueta para el traje.	La etiqueta está atada al traje con un hilo negro.	
2	Ya hay móviles en la tienda.	Tiene que ir a otra tienda para comprar un móvil.	
3	Ya tienen escoba para el piso.	Ella toma la escoba y barre el piso.	
4	No hay peine en el tocador.	Se peina con el peine antes de salir por la mañana.	
5	Ya hay tenedor en la bandeja.	Entonces le pide al camarero que le traiga un tenedor.	
6	Ya hay papel en la impresora.	Entonces puso papel en la impresora para poder imprimir.	
7	Ya tienen tijeras en el cajón.	Saca las tijeras y corta la cuerda con ellas.	
8	Ya tiene pañuelo en su bolso.	Usa el pañuelo para limpiarse la mano.	
9	Ya tienen cerveza en los vasos.	Bebe varios vasos de cerveza con sus amigos.	
10	No tienen frutas en el pastel.	El pastel solo está hecho de chocolate y crema.	
11	No tienen galletas en la bolsa.	Porque ayer no compró galletas en el mercado.	
12	No hay alcohol en el botiquín.	Irá a la farmacia a comprar alcohol.	
13	No hay refresco en los vasos.	Porque a los invitados les gusta beber vino.	
14	Ya hay teléfono en su oficina.	Entonces llama a sus clientes con su móvil.	
15	Ya tienen helados en la cocina.	El niño le pide a su padre que le compre helado.	
16	No tienen bebidas en el maletero.	Cogen las bebidas del coche para tomarlas en la barbacoa.	
17	No tienen carteles en el pasillo.	Los carteles anuncian las nuevas películas.	
18	Ya hay corbatas para el traje.	Se pone una corbata gris para combinar con su traje.	
19	Ya hay velas en el pastel.	Enciende las velas y canta la canción de cumpleaños.	

20	No tienen tinta en la impresora.	La secretaria abre el archivo y lo imprime.	
21	No hay cuchara en la bandeja.	Se comerá la sopa con la cuchara.	
22	No tiene monedas en su billetera.	Entonces compra el billete de tranvía con la tarjeta.	
23	Ya hay equipaje en el maletero.	Llevará el equipaje al aeropuerto por su esposa.	
24	No tiene sudor en su frente.	Porque lo acaba de limpiar con una servilleta.	
25	Ya hay sábana en su cama.	Entonces la madre extiende una sábana sobre su cama.	
26	No tienen abrigo en el perchero.	Porque la madre dobló el abrigo y lo puso en el armario.	
27	No hay manzanas en la nevera.	Saca una manzana de la nevera y se la come.	
28	No tienen mantas en el sofá.	Se tapa con una manta ya que siente frío.	
29	Ya hay tarjetas en su billetera.	Tiene que pagar el almuerzo con efectivo.	
30	No tienen toalla en el baño.	Después de ducharse no tiene con que secarse.	
31	No hay pollo en el microondas.	Porque la madre sacó el pollo del microondas hace unos minutos.	
32	No hay monos en la jaula.	Porque los monos están jugando en el árbol.	
33	Ya tienen lirios en la floristería.	Entonces compra un ramo de rosas para su novia.	
34	No tienen anillos en la joyería.	Compra un anillo de oro para su prometida.	
35	Ya tienen suciedad en la ventanilla.	Porque ella limpió la ventanilla hace un momento.	
36	Ya tienen tiritas en el botiquín.	Toma una tirita y se la coloca en el dedo.	
37	Ya hay camisas en el armario.	Elige una camisa blanca para combinar con sus pantalones.	
38	Ya tiene llaves en su bolsillo.	Entonces toca el timbre para que le abran la puerta.	
39	Ya tienen radio en el estante.	Enciende la radio para escuchar el programa.	
40	No hay baterías en el cajón.	Sale a comprar una batería para el despertador.	

41	No tiene vestidos en el armario.	Elige un bonito vestido del armario para la fiesta.	
42	Ya hay aceite en la sartén.	Echa aceite en la sartén para freir el bistec.	
43	Ya hay pulseras en la joyería.	Compra una pulsera para su amiga en la joyería.	
44	No tienen roturas en la ventanilla.	Llamará a un mecánico para reparar la ventanilla.	
45	Ya hay cojines en el sofá.	Se apoya en los cojines para sentirse cómodo.	
46	No tienen perros en el patio.	Los perros están en el sofá junto a su dueño.	
47	Ya tienen zumos en la cafetería.	Tiene que pedir café en lugar de zumo.	
48	No hay sandía en la cocina.	Corta la sandía en pedazos y los comparte con su familia.	