The Cumulative Semantic Interference effect in L2 Italian-Indonesian late bilinguals

Implications from a mixed production-comprehension task

Student: Dario De Falco
S1016705
Date: 22/03/2021
Psycholinguistics
Supervisor: Dr James McQueen
Second reader: Dr Stefan Frank

Table of contents

Abstract

This study investigated the mechanism of lexical access and selection in bilingual speakers through the analysis of the Cumulative Semantic Interference (CSI) effect, a semantic context effect detected in several speech production tasks. This study aimed to test three hypotheses. First, it is predicted that there is an effect of the ordinal position of trials reflected in a gradual slowing down in the reaction times of the naming latencies. Second, it it is believed that the CSI effect persists across modalities. That is, the two modalities of presentation employed in the study (visual or mixed with auditory stimuli) would show similar naming latencies, and hence, similar effects of ordinal position. Finally, it is assumed that the CSI effect persists across languages despite different modalities of presentation (from auditory L2 stimuli to L1 picture naming). That is, equivalent naming latencies across two unrelated languages lacking cognates (Italian and Indonesian) should be found. Based on these three hypotheses, a revised structure of the Conceptual Accumulation account from Belke (2013) has been proposed in order to provide an additional insight of the architecture of lexical selection in a bilingual context.

To test these hypotheses, a mixed production-comprehension task has been created. This task consisted not only of two modalities of presentation, but also a language alternating condition according to the modality. The task presented 4 items from 36 semantic categories in a continuous fashion. In the first modality of presentation, participants were presented with pictures from a given semantic category, which needed to be named in Italian, while in the second one participants heard words in Indonesian and named pictures in Italian all belonging to the same semantic category, such as ‘animal’.

Due to the COVID-19 outbreak collecting experimental data was not possible anymore. As an alternative, data simulation and tests were performed using empirical reaction times (RTs) derived from a similar study and applying them to the current research design in order to get a simulated result of the expected experimental task.

Does cumulative semantic interference effect persist across languages and across modalities? This question remains unanswered, so the present study provided speculations in the event the predicted hypotheses were found to be true.

1 Introduction

The present study aims to investigate the mechanism of lexical access and selection in bilingual speakers. This will be achieved, in part, by analyzing a kind of semantic context effect known as the cumulative semantic interference (CSI) effect. An experimental task will test three predictions about this effect with regards to the semantic-to-lexical mapping process in bilingual contexts. The results of the performed analysis should provide insights into the architecture of lexical selection in bilingual speakers.

1.1 Lexical access in speech production

The current section aims to illustrate the two major lexical access theories in speech production. The hypotheses regarding the mechanisms by which lexical access occurs in speech production remain the topic of an ongoing debate.

The first part of this section (1.1.1) will present the outline of the lexical access model (Levelt et al., 1999), as well as the semantic effects (namely semantic inhibition and semantic facilitation effects) from empirical reaction time studies employed in their research (e.g. Glaser and Düngelhoff, 1984). In the second section (1.1.2), a contradictory perspective from a different author (Caramazza, 1997) concerning the matter of the lexical access processes will be provided.

1.1.1 The lexical access model

The theory presented in the study of Levelt, Roelofs & Meyer (1999) argued that word production is a staged process, and each stage has an influence on the final output.

Their study aimed to cover different aspects of the lexical access process by analysing previous studies' existing evidence (e.g. speech errors). The study also provided a new approach that considered reaction times (RTs) as a means of analysis to investigate the staged word production process. The authors claimed that this measurement, namely RT, was relevant because it represented an ideal time course of the lexical access process itself.

As depicted in Figure 1, the mentioned stages are: conceptual preparation, lexical selection, morphological encoding, phonological and phonetic encoding, and articulation.

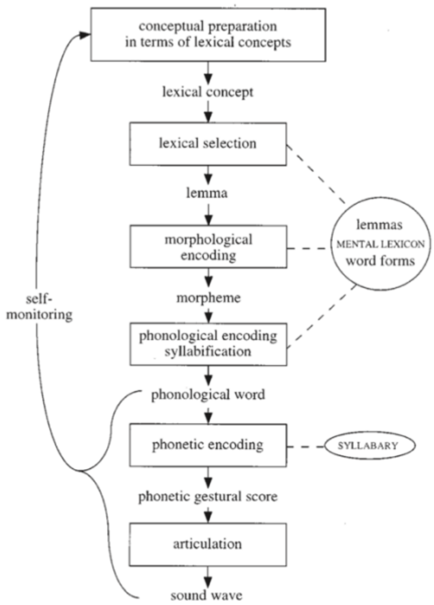

Figure 1: Outline of the processing stages theory (Levelt, Roelofs & Meyer, 1999)

The primary investigation aimed to see whether these processing stages overlap in time or they take place sequentially. As stated in the study, the whole process consisted of a feed-forward activation-spreading network.

The conceptual preparation characterised the first stage. This stage is mediated by perspective-taking, which is a context-dependent (pragmatic) deduction to select the proper concept.

The second stage highlighted lexical selection, namely the retrieving process of the lemma. In *Figure 2,* a fine-grained overview of this process is represented by taking node activation also into account. Nodes are properties of the activated item (a node can be a concept or conceptual features, a lemma, a morpheme, or a phoneme) and consist of networks. At this stage, the conceptual node of a given lexical concept is activated. For instance, HAMMER, and it spreads its activation to the related lemma, which is 'hammer'. Thus, lexical concept activation spreads to its lemma node. Once the lemma is activated, grammatical encoding also occurs to select the correct properties according to the syntactic context. Person, number, tense, aspects, and lexical category (e.g. noun, verb, adjective, adverb, etc.) are all nodes (properties) of a lemma.

The third stage consisted of morphophonological encoding. After selecting the most appropriate lexical item in the previous stage, the theory affirmed that three types of information activate at this stage: the word's morphology, metrics, and segmental composition. The first encoding accesses the word's morphemes. Then the encoding of its metrics and segments takes place. The metrical information encoding analyses the word's syllabic number, its stress placement, and whether it can be a prosodic unit. Segmental encoding, on the other hand, fills in each word's phonemes (see *Figure 2*).

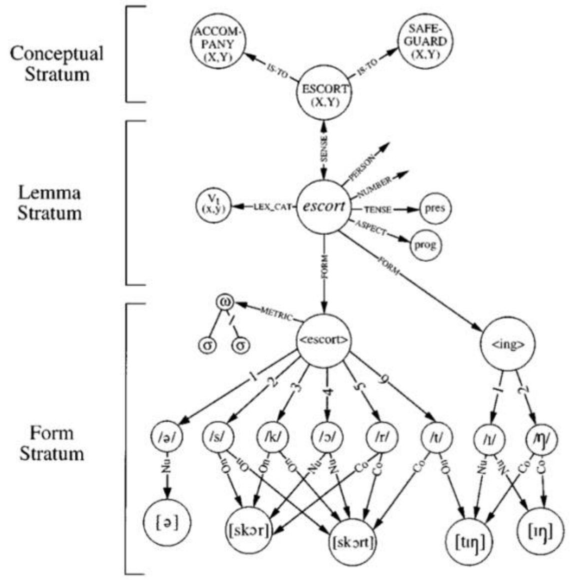

Figure 2: Lexical access process and lexical network (nodes) (Levelt, Roelofs & Meyer, 1999)

The last stage regarded the phonological word's gestural score. This stage involves the articulatory system, which controls the motor system and the gestural score.

In *Figure 1*, on the left side of the diagram, there is self-monitoring. Self-monitoring is a mechanism that the individual runs while speaking. As reported, it monitors the speech output, detects speech errors or other problems related to overt speech.

After providing the grounds of the mentioned lexical access theory, the authors investigated their predictions by developing a computational model (WEAVER++), which would test the ability of the staged lexical access theory to account for reaction time data, for example, from an experiment from Glaser and Düngelhoff (1984).

More specifically, the source of data analysed by Levelt et al. (1999) consisted of RTs deriving from both a picture-word interference naming task and a picture (and word) categorising task.

The picture-word interference naming task consisted of the naming of the presented picture with the co-occurrence of semantically- or not semantically-related distractors in the form of written words. The distractor occurrence is called SOA, which stands for stimulus onset asynchrony. There are two types of SOA: negative and positive. The negative SOA sees the distractor onset placed between 400 ms and 100 ms before picture onset. The positive SOA, however, refers to the simultaneous placing of the distractor with picture onset in the same time window.

The second task was a picture and word categorising task that required participants to classify an item by semantic category. For example, if a dog's picture is presented to the subject, its categorisation would be animal.

Levelt et al. (1999) stressed two findings from Glaser and Düngelhoff (1984). On the one hand, in the naming task, results showed different semantic effects according to different SOAs. More specifically, a semantic inhibition effect took place at SOA -100ms and SOA 100ms. On the other hand, distractors did not bring an inhibition effect in the picture and word categorising task, but rather a semantic facilitation effect which accounts for faster naming latencies according to the stimuli.

To these results, the authors fitted the WEAVER++ computational model. According to the picture-word interference naming and the categorising task, the simulation of lemma retrieval took into account both small (minimal nodes needed) and more extensive networks and followed parameters developed on the base of the study itself (considering SOA curves) to predict the phenomena.

The first explanation reported by the model regarding the semantic inhibition effect during picture naming assumed that showing pictures in this task would result in the activation of the related basic concepts. For instance, *chair* was the target item (picture), and its corresponding basic concept was *furniture*. *Bed* was the distractor word. According to the authors' assumption, the picture's activation and the word's activation would converge at the distractor's lemma. Moreover, because of the distance of the links, the pictured *chair* would prime the word distractor *bed* because the first input (picture) would present fewer links (three links) to achieve the final naming rather than the word *bed* (four links).

Thus, the authors represented these links as follows: [pictured chair → CHAIR(x) → BED(x) → *bed* vs word "bed" → *bed* → BED(x) → CHAIR(x) → *chair*] (Levelt, Roelofs & Meyer, 1999, p. 11). Also, comparing the word distractor *bed* with an unrelated word distractor such as *fish*, the first one would result in a stronger competition between the two because of its relatedness.

The same outcome was predicted for the facilitation effect in picture or word characterisation, which is in line with the empirical SOA evidence. In this case, instead of having words belonging to a semantic category as target items, targets were semantic categories. According to the model for this facilitation effect, the provided reason is that the written distractors would be competitors in the experiment only when they are permitted responses and part of a response set (Levelt, Roelofs & Meyer, 1999, p. 11). In this case, *bed* did not represent a proper response – because it was not shown as a word distractor in other trials – and would trigger the priming of *furniture*.

As shown in this paragraph, the interactive lexical access model proposed by Levelt et al. (1999) assumed that the organisation of lexical access based itself on a feed-forward activation-spreading network. When a lexical entry (lemma) is activated, also related lexical entries are co-activated. Lexical access is a staged process, and each stage spreads the activation to its nodes. The threshold needs to exceed the activation of all the competitive related lexical entries to select the correct lexical entry.

Also, picture naming semantic inhibition effects are due to picture-distractor semantic relatedness, which results in a competitive feature in the target lemma's activation process. The following paragraph will illustrate an alternative perspective regarding the structure of the lexical access process.

1.1.2 The Independent Network model

In 1997, Caramazza published a study reviewing the lexical access system, thereby proposing a model in which lexicon is organised in sets of independent networks linked to each other by a modality-specific lexical node (Caramazza, 1997, p. 194).

Figure 3 represents the structure of the Independent Network model. This model consisted of three networks which are: 1) lexical-semantic networks which store word meanings, semantic features, and properties; 2) lexical-syntactic networks which contain grammatical properties, gender, number, etc.; 3) phonetic- and orthographical- lexeme networks which store modality-specific representations of lexical items. There are subnetwork nodes within each network representing category nodes (for instance, in the lexical-syntactic network, there are verbs, nouns, adjectives, or gender, there is masculine or feminine). Also, the author reported that these subnetwork nodes are competitive in the activation process. Thus, they have inhibitory links represented in *Figure 4* as well as the activation flow, which follows a top-down course until the final output of the word.

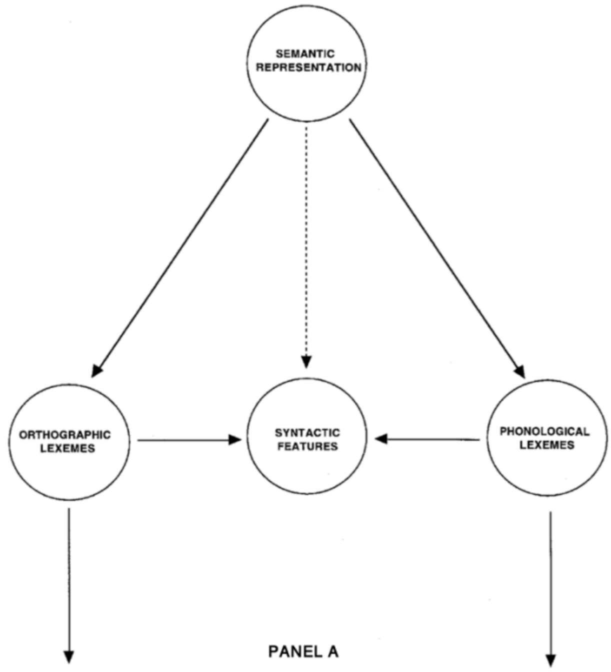

Figure 3: Structure of the Independent Network model (Caramazza, 1997, p 196)

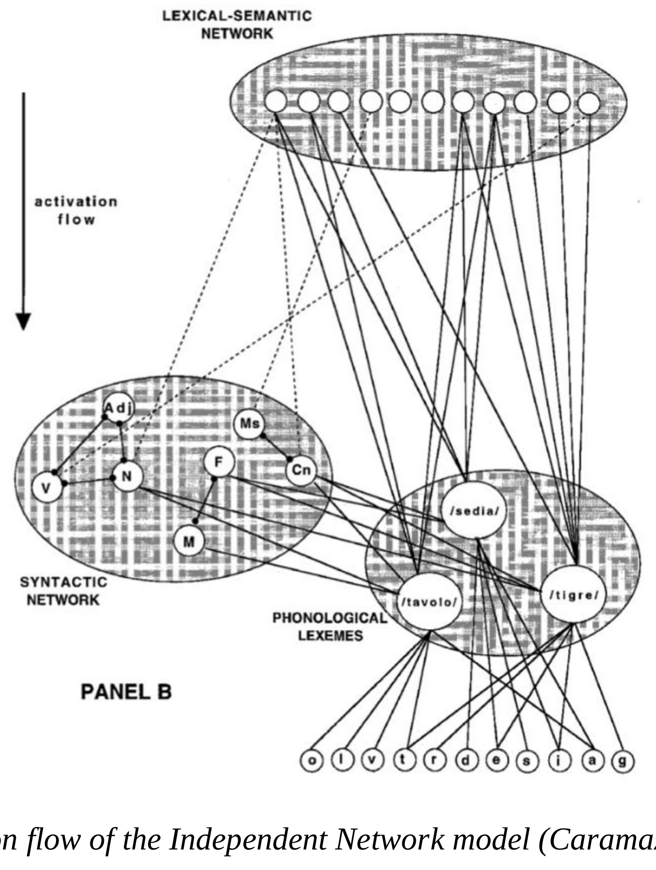

Figure 4: *Activation flow of the Independent Network model (Caramazza, 1997, p. 197)*

Caramazza stressed an interesting point that arose from analysing the neuropsychological literature. What they observed was that subjects produced modality-related errors. More specifically, subjects could make correct responses in one modality of output, for instance, writing the target response, but not in the other modality, such as an overt speech response. As reported in the study, the errors were lexical substitutions of the target response. From this result, Caramazza postulated that both the lexical-semantic level of representation and the lexical-phonological knowledge were not damaged. Thus, as production led to semantic errors, the author stated that the locus of the damage was at the mapping process of lexical representation between the meaning itself and lexical form. The author then deducts that the two systems do not interact. One of the two could be damaged without affecting the other one.

By reviewing this evidence, Caramazza reported the so-called Independent Network hypothesis, which stated that:

- Lexical-semantic, syntactic, and modality-specific form representations are discrete
- The semantic representations individually activate phonological lexemes and orthographical lexemes
- A selected lexical-semantic representation triggers the activation of all lexemes of words sharing similar semantic features based on semantic errors
- Lexical-semantic and lexeme levels are linked, but syntactic representations represent a separate network

The review of the two primary lexical access theoretical models reported in this section has shown two different perspectives on the lexical selection process's architecture. On the one hand, this architecture (in section *1.1.1*) consists of a feed-forward spreading-activation system that starts at the conceptual level and ends at the articulatory level. On the other hand, in the second section (*1.1.2*), a contradictory model shows a different perspective about the lexical selection process, which consists of a model comprising three independent networks (semantic, syntactic, (phonetic) and orthographic) and inhibitory subnetwork nodes within each one.

The following sections will present and discuss the cumulative semantic interference effect, which will be the present study's object of analysis.

1.2 Overview of the Cumulative Semantic Interference studies

1.2.1 The Cumulative Semantic Interference effect

The cumulative semantic interference is a semantic context effect identified in word production tasks involving the naming process of a set of pictures from the same semantic category thereby affecting the lexical-semantic encoding processes. This effect shows an increasing slow-down – by measuring the reaction times (RTs) – in the naming latencies of semantically-related picture sets (thus, reporting slower RTs compared to the naming of semantically-unrelated word sets) as a function of ordinal position. More specifically, the paradigm assesses that the speed with which a subject can name a given item is affected by whether or not items from the same semantic category have been named previously.

The CSI effect has been found in several experimental studies employing different naming paradigms (e.g. continuous naming task or blocked-cyclic naming task), and it opened a series of theoretical discussions regarding the origin of this effect, followed by the postulation of different explanatory accounts.

Yet, before discussing the CSI effect in its totality through the revised literature, taking a step back and discussing the origin of semantic context effects in object naming is needed to understand the probable origin and locus of the CSI effect itself.

1.2.2 The Conceptual Accumulation account

The study of Belke (2013) helps to provide evidence of the locus and origin of the semantic context effects in object naming, which encompassed the CSI effect as well, utilising two semantic context manipulations, namely: blocked and continuous object naming.

The manipulation of semantic naming context has shown that repeated activation of semantic categories leads to semantic interference (Howard et al., 2006; Damian et al., 2001; Kroll & Stewart, 1994).

To establish the hypothesis about the origin of semantic effects, Belke transformed the two paradigms into a tool for analysing lexical-semantic encoding. The central question was: Where do the effects originate, and where do they come into effect? For instance, Howard et al. (2006), showed that the origin of the inhibitory effect occurs at the convergence between the conceptual and lexical levels and comes into effect at the lexical level.

However, according to Belke's (2013) theory, semantic context effects originate at the conceptual level and come into effect at the lexical level. This effect would occur via a spreading interactive activation process, similarly to Levelt et al. (1999) model. Prior to the hypothesis testing by means of experimental tasks, the author developed an explanatory model showing the representations and the processes involved in the lexical-semantic encoding (Belke, 2013, p. 231).

This model consisted of three-strata, which considered a multi-mapping of conceptual features onto lexical concepts. More specifically, according to the author, lexical concepts possess multiple shared conceptual features, but the latter singularly connect to the lemma. For instance, although *fish* and *penguin* share similar conceptual features such as 'is an animal', 'can swim', the link between the first two levels are distinct. *Figure 5* below shows the structure of the three-strata model developed by the author.

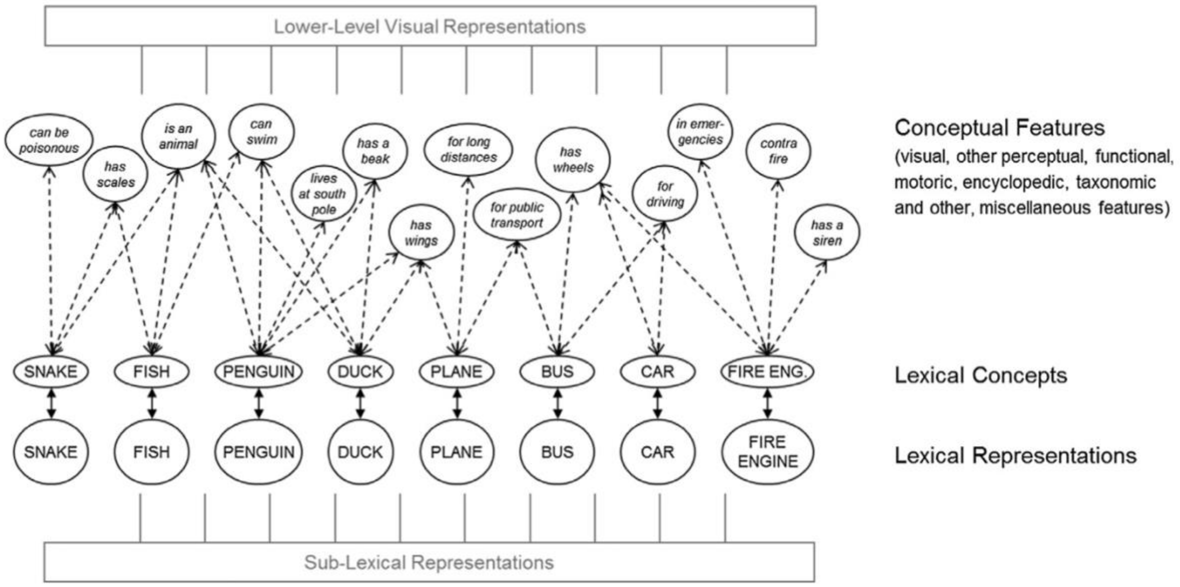

Figure 5: Three strata lexical-semantic model of Belke (2013)

There are many conceptual features mapped onto a single lexical concept, and lexical concepts are singularly linked to their lexical representations. In the model, we see that lexical concepts and lexical representations are bidirectional because they co-activate each other through the shared conceptual features.

From the object's visual presentation, the first encoding process involves the activation of visual features at the first stratum (conceptual features), which subsequently activates lexical concepts (second) and lexical representations (third). In this process, through spreading interactive activation, the lexical retrieval mechanism was expected to result in a wider lexical-semantic network involving related conceptual features, lexical concepts, and lexical representations because of the shared features, which will ultimately produce competition for lexical selection.

From the given working model, Belke's hypothesis predicted that the repeated activation of conceptually-related representation generates a conceptual accumulation that delays target lexical selection and yields an inhibitory semantic context effect. This hypothesis could explain the reason for the cumulative semantic interference effect in object naming in both blocked-cyclic and continuous naming paradigms, which will be discussed in the following paragraphs.

1.2.3 CSI effect in the continuous naming paradigm

Earlier it was stated that CSI occurs in various naming paradigms, and the continuous naming paradigm is one of them. The paradigm is an experimental semantic context manipulation involving the naming of a sequence of exemplars in a continuing fashion. These exemplars, belonging to various semantic categories, are arranged so that participants will name them once only. Those exemplars are presented so that participants would not become aware of the relationship between items.

For instance, the CSI effect was found in a study conducted by Howard et al. (2006). In the first part of this study, the authors shed light on what extent semantic priming is cumulative according to the previous semantically-related stimuli and to what extent the presence of lags (namely the intervening of not-related items between the target items) interacts with this cumulative semantic priming.

Participants had to name a sequence of 165 experimental items (120 target pictures and 45 fillers) to measure it. There were five target items from 24 categories mixed together in this sequence, presented in a continuous fashion, and were separated from each other with a number of lags (namely items belonging to different semantic categories or fillers). The authors counterbalanced the number of lags varying from 2 to 8 in both within and across participant conditions. Placing lags between target items allowed the authors to minimise the chance that subjects could become aware of the specific presented target items belonging to the same semantic category as well as to avoid "*short-term effects of naming items drawn from one semantic category*" (Howard et al., 2006, p. 468).

Overall, there was a significant effect in the picture-naming latency, which significantly and gradually slowed down for each target (semantically-related) item presented both by subjects and by categories. However, this effect did not occur as a function of lag, namely, the presence of intervening items between semantically-related exemplars did not affect picture-naming latency but as a function of ordinal position within a given semantic category.

From these empirical results, Howard et al. (2006, p. 471) developed a model that possessed three properties which, according to the authors, any speech production models must have if the aim is to explain the above mentioned semantic effect. More specifically, these three properties are competition, priming, and shared activation.

The first property, competition, is identified by a delay in the production of a target output due to the activation of semantically related competitors. This activation of semantically related candidates slows down the final output of the target item as a consequence of an inhibitory process on the other semantic candidates. Unlike Belke (2013), the authors do not show at which level the competition occurs, but rather they mention that competition occurs at a post-semantic level (Howard et al., 2006: 478).

The second predicted property consisted of priming of the prior presented target item of a given semantic category even though there are a number of intervening stimuli between the primed item and the following semantically-related item.

Finally, the third property reported was an activation (to a lesser degree) of semantic nodes of semantically-related words must also be present. Linking back to Levelt et al. (1999), the feed-forward activation-spreading network can strengthen the activation of the semantic nodes of semantically-related words.

To demonstrate that these three properties were sufficient for generating a cumulative semantic interference effect and could support their empirical evidence, the authors developed a computational model (and specific equations) which incorporated all of them.

The model simulated the 165 items presented in the experimental task, labelled as S-level units ('S' stands for semantic). Each S-level unit was a semantic representation of a word, and it was linked to the second unit level, namely the L-level unit ('L' stands for lexical). The latter unit consisted of the lemma system. The architecture of this model is reported in *Figure 6* here below.

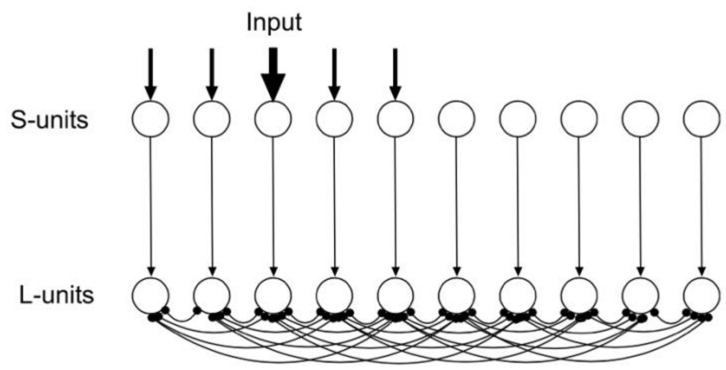

Figure 6: Structure of the computational model reported in Howard et al. (2006, p. 472)

The model consisted of the S-unit activation (via an external input) related to the target word and the activation (at a lesser level) of close S-units that relate to semantically-related target words. *Figure 6* represents the external input as a more prominent arrow than the other indicators representing the shared semantically-related S-units. Between S-units and L-units, there is a link that represents priming. At the L-units level, multiple connections are depicted, and those represent semantic nodes that, as reported previously, are competitive. The activation starts from the external input, which turns on the S-unit plus the semantically-related S-units. Afterwards, the activation shifts to the lexical units linked to each other via their semantic nodes. Once the lexical unit reaches a threshold, the priming strengths the connection between the S-unit and the L-unit, thus the response output is made accessible (Howard et al., 2006, p. 472).

The authors ran the computational model in several conditions (e.g. eliminating one of the three properties) in order to show whether the three mentioned principles were necessary so that the cumulative semantic interference effect can occur or not. These simulations showed that the three properties are indeed required to produce an inhibition effect in speech production (Howard et al., 2006, p. 476). Therefore, when they set *priming* or *shared activation* to zero, cumulative inhibition did not occur. When they set *inhibition* to zero, thus no competition due to inhibitory connection between lexical units, no CSI effect occurred (Howard et al., 2006, p. 475). According to the authors' opinion, this result falsified current theories regarding spoken word production models in the matter of the CSI effect. They could not simulate the effect because they lack the inclusion of the three properties discussed above.

While Howard et al. (2006) focused on what triggers a CSI effect, Schnur (2014) carried out a study focused on whether CSI in the continuous naming paradigm was persistent as a function of time and lags. More specifically, the study aimed to analyse naming latencies by increasing the response stimulus interval (RSI) – namely the delay between when a participant produces a response and when the next item appears – and the number of intervening unrelated items.

In order to test these two predictions, the author conducted two experiments. The first one aimed to test CSI as a function of time of RSI and ordinal position. The pool of participants consisted of two groups of 24 students. Subjects had to name 172 drawings of nouns. Of the 172 pictures, 120 were target items – consisted of 24 semantic categories – and 52 were fillers. Similar to the study of Howard et al. (2006), this study kept both the number and the fashion of the intervening items constant within target items belonging to the same semantic category.

One group (24 subjects) had an RSI of 750 ms, and the other one (24 subjects) had an RSI of 5250 ms.

Three main results rose from the first experiment. The first revealed that picture-naming latencies became gradually slower across target items of the same semantic category; thus, the ordinal position effect was present. This slowing down, however, did not depend on the number of lags. The second reported that by comparing the two RSIs (thus 5250 ms vs 750 ms), it appeared that responses were slightly slower in the first-time frame. Still, the difference was not significant as there was no interaction with any factor. The third one showed that across ordinal positions, the interference effect did not differ, considering RSIs.

The second experiment tested CSI as a function of lags. None of the participants in this experiment joined the first one. The procedure was the same, except RSI was kept constant to 750ms, and the number of lags was significantly increased. In order to test the effect of lags, the author decided to break this experiment into two parts: 2a and 2b. On the one hand, 2a included a number of lags between 20 and 50 intervening between target items. On the other hand, the number of lags in 2b was substantially lower (between 8 and 14). However, the second experiment results reported no significant effects as a function of lags for both 2a and 2b.

In conclusion, the reported results showed that CSI is quite persistent as a function of ordinal positions (e.g. 1st *dog*, 2nd *cat*, 3rd *cow*, 4th *chicken*, 5th *goat*). Still, it had no interaction with the number of lags between target items (i.e. 2, 4, 6, or 8) or according to a given response stimulus interval (i.e. 5250 ms vs 750 ms).

1.2.4 CSI in blocked-cyclic naming tasks

The CSI effect does not only occur in the continuous naming paradigm. Therefore, it also appeared in other types of naming paradigms, such as the blocked-cyclic naming task. So, the following paragraph will report further evidence of the CSI effect in the latter naming task.

The blocked-cyclic naming paradigm is an experimental semantic context manipulation involving sets of shuffled items to be named repeatedly. These sets include groups of heterogeneous items, namely semantically-unrelated stimuli (e.g. *shoe*, *bus*, *hammer*, *table*), and groups of homogeneous items, namely semantically-related items (e.g. *fish*, *duck*, *snake*, *mouse*). Participants were found to be slower in the homogeneous naming contexts.

In the study of Damian et al. (2001), the author attested the presence of a semantic context effect taking place in two experiments involving manipulations of the semantic naming context involving 20 monolinguals (German): 1) a block-cyclic naming of pictures; 2) a block-cyclic naming of words.

Starting from the first experiment, the authors arranged the semantic context manipulation (homogeneous vs heterogeneous) in a within-subject variable. There were twenty experimental blocks (ten homogeneous and ten heterogeneous blocks) presented so that five consecutive blocks were of the same type. Each block presented target pictures in a pseudorandom fashion such that the same picture never appeared on successive trials.

The authors reported a significant semantic context effect in the homogenous trials. Compared to the heterogeneous trials, the naming latencies of semantically-related blocks were 29ms slower than the unrelated ones, and this difference was significant.

The second experiment had a similar design, but it employed the use of noun + determiner' sets (NP) and 'bare noun' sets (N), still divided into heterogenous and homogenous blocks and aimed to include also grammatical encoding of target items. Results showed that response latencies of homogenous items belonging to the NP blocks were 11ms slower than those from the heterogeneous set. Of the N blocks, response latencies in homogenous groups were faster than the response latencies of the heterogeneous sets, assuming a facilitation effect.

Regarding the interference effect found in NP naming, the authors explained that, compared to the N naming, having a determiner before the noun allows access to a more complex lexical-semantic coding which entitles access to the lemma-level properties of the noun, namely its syntax. In short, the NP naming results slower because of additional lexical-semantic retrieval processes compared to N naming.

In Belke (2013, p. 232), the author discussed the lexical access model of Levelt et al. (1999) and claimed that the visual presentation of the item triggers the activation of visual features at the concept level, which in turn would subsequently activate its related lexical concepts and lexical representations. From this statement, Belke traced a link with what the concept accumulation hypothesis assumed: continuous access to related conceptual representations would generate more levels of conceptual activation, which inhibits the selection of a target at the lemma level from among its related lemmas, and produces an inhibitory semantic context effect on object naming times.

As discussed in the previous paragraph, the study's purpose was to localise the origin and locus of this effect which was attested to take place either in the blocked-cyclic or in the continuous paradigm. Experiment 2 in the study showed a semantic context manipulation combined with a semantic classification task. Differently from the study of Damian et al. (2001), the author created a variant of the blocked naming paradigm that allowed to block stimuli per semantic category without blocking according to the response type by randomising lists having one homogeneous and one heterogeneous object set. The author reported that in the blocked object naming paradigm, both inhibitory and long-lasting semantic context effects, as well as facilitatory effects on semantic classification, occurred alongside each other. As reported, inhibitory semantic context effects also persisted during tasks alternation (naming picture trials vs naming word trials). The semantic interference was robust in picture naming trials but not significant in word naming trials.

1.2.5 From listening to picture naming: transfer of cumulative semantic effects

Hoedemaker et al. (2017) discuss important implications regarding the CSI effect in the continuous naming paradigm. According to the authors, the CSI effect seems to be transferred as a function of turn during a picture naming task.

The central goal of this study was to investigate whether there was a noticeable difference in self- and other- produced speech production tasks, more specifically in a joint version of the continuous naming paradigm. To achieve this goal, the authors defined two hypotheses based on the literature, specifically on the work of Howard et al. (2006) and Belke (2013).

As stated in Howard et al. (2006), the CSI effect occurs in a speech production task involving lexical retrieval. Taking this statement into consideration, Hoedemaker et al. (2017) predicted that semantic-to-lexical mapping should not arise in other-produced naming yielding only a within-speaker interference. More specifically, it would not interfere with the speaker's target item naming belonging to the same semantic category of the other speaker's responses (across-speaker interference). On the other hand, the Conceptual Accumulation account reported in Belke (2013) states that the origin of semantic context effect (and thus CSI effect also) is at the conceptual level. Repeated activation of conceptually-related representation generates a conceptual accumulation that delays target lexical selection (for object naming) and yields an inhibitory semantic context effect.

The two models investigated the semantic context effects without considering that in everyday language, yet interlocutors shift from the comprehension to the production of utterances. Thee experimental context comprised self- and other-produced utterances, and it was not yet clear what were the effects of a previous production or comprehension on subsequent production or comprehension in such context (Hoedemaker et al., 2017, p. 56). Thus, the authors finally predicted that the CSI effect would result in both within- and across-speakers.

In order to investigate the potential effect across speakers, they manipulated the design according to the modality of presentation. More specifically, the manipulation consisted of grouping participants in pairs who took turns speaking and listening to the partner's object naming. This manipulation was crucial because the authors wanted to test whether the semantic-to-lexical mapping in lexical retrieval in self-produced object naming would occur simultaneously while the partner was hearing the partner's object naming thus predicting the speaker's response.

The study employed a total of 165 items. Stimuli consisted of 24 semantic categories. Target items were shown with a number of lags varying from 2 and 8 across the task between target items. The naming task followed a fashion so that within one pair of participants, half of the categories would have been named by one member and the other half by the other member. More specifically, given one list divided into two halves, in one half, participant A would have named, for instance, the first, third, and fifth target item of a given semantic category, and participant B only the second and fourth target item. The other half would have followed the reversed fashion. Thus participants B had to name the first, third, and fifth target item of a given semantic category and participant A only the second and fourth target item.

Results showed no effect in terms of number of lags on naming latencies. Moreover, naming latencies slowed down as a function of round (divided into ordinal position 1 and 2; ordinal position 3 and 4), inferring a within-participant CSI effect. This slowing down evidence also appeared as a function of turn (participant A vs participant B), inferring an across-participant effect. Regarding the manipulation of stimulus presentation, the author reported a consistent slowing down of 18 ms when the listener was shown the speaker's to-be-named picture compared to the blank presentation. Accuracy was reported in the analysis and showed that it did not vary as a round or turn function.

In summary, the authors adequately demonstrated that the CSI effect operates across speakers within a naming task. Hearing the other-produced semantically-related target items naming of a given semantic category will interfere with the subsequent self-produced naming when the participant's turn comes. This is consistent with Belke’s (2013) conceptual accumulation account supporting the locus of this semantic context effect at the conceptual level. Thus, these findings are more related to the preparation, organisation, and selection of the conceptual representations.

Semantic context effects are only one feature of the broader unified computational account proposed by Roelofs (2018) and reported in the following paragraph to show a possible explanation of these semantic effects in picture naming paradigms.

1.2.6 CSI in computer simulations

The study of Howard et al. (2009) concluded that the current theoretical models of spoken word production lack the inclusion of three necessary properties: competition, priming, and shared activation.

Thus, Roelofs (2018) reported a newly implemented version of the WEAVER++ speech production model, demonstrating that the model did not lack necessary properties, but rather they needed to be implemented. So, in this new version, the model took into account the effects of three paradigms, namely, continuous naming, blocked-cyclic naming, and picture-word interference. By including three new features to the computational model: conceptual bias, accounts (such as the conceptual accumulation by Belke) for cumulative semantic effects, and accounts for semantic blocking effects. The previous version of the model assumed the presence of competition but no inhibition. Hence, in Levelt et al. (1999: 6), the authors assumed that node selection could be subject to competition within a stratum, but there are no inhibitory links in the links both within and between strata. Also, the lexical access model was developed encompassing one single task only, namely the picture-word interference task.

The new study, therefore, proposed a unified account of the semantic effects and consisted of two main assumptions: lexical selection represents a competitive process; within the lexical selection process, the semantic effects take place at the conceptual level and come into effect at the lexical level. Moreover, it replicates cognitive processes and takes into account RT findings in speech production. In short, it considers the human neurocognitive functions and predicts a reaction time given a (semantic) context.

Regarding the first feature, namely conceptual bias, the author included this element in a revised function. The conceptual bias assumption predicted that selecting a lexical concept (for example naming the picture depicting an apple where the activated concept is APPLE) generates a temporary bias towards the concept, which interferes with the following processing of other semantically-related lexical concepts (such as PEAR) (Roelofs, 2018, p. 64). As explained in his article, every time a lexical node was selected, a bias term was added and subsequently selected. After that, the model follows the threshold exceedance mechanism among all the competitive lexical entries, a feature that was already present in the previous version, to select the target lemma. The author also reported that the introduction of this feature might also account for the cumulative semantic and semantic blocking effect.

The second and third feature incorporated what Belke (2013) postulated in the Conceptual Accumulation account, namely that the origin of semantic context effects is at the conceptual level and comes into effect at the lexical selection.

To explain the cumulative interference effect, computer simulations were run explaining that this effect is due to a *divergent mapping* (Roelofs, 2018, p. 65) of lexical concepts (for example, *apple, pear, banana, melon*) onto lemma responses which comprise properties such as words number, gender, case, etc. In this divergent mapping, the lexical concepts compete for selection, and a conceptual bias leads to a semantic interference as a function of the number of semantically-related pictures named previously, explaining empirical evidence regarding the linear slowing-down of the response latencies in semantically-related object naming. The WEAVER++ picture naming results showed that the naming latencies in the simulations increased by an additional 11 ms per ordinal position. However, comparing these results to empirical data from Belke (2013), this gradual increase was smaller than Belke's data, reporting a slowing down of naming latencies of about 21 ms per ordinal position in picture naming, or in Howard et al. (2006) which was about 30 ms per ordinal position.

The WEAVER++ picture naming computer simulations explained the first key assumption stated at the beginning of the paper, namely lexical selection as a competitive process, by running a computer simulation and getting similar results of the empirical data. Also, by including the conceptual bias in the model, the author provided a further explanation for semantic effects in naming tasks which will be taken into account in the present study.

1.3 CSI effect in bilingual contexts

Thus far, the CSI effect occurred in experimental tasks involving monolinguals. However, this effect is found in bilingual experimental contexts as well. This discovery opened the discussion regarding why this inhibitory effect occurs in such a context and to what extent. Extending the focus to bilingual boundaries would help understand how the CSI effect is also present in such experimental contexts operating similarly to the monolingual ones. Thus, the following section will discuss the CSI effect in bilingual contexts as well as its implications.

1.3.1 The Inhibitory Control Model (ICM)

Green's 1998 article regarding the Inhibitory Control Model (henceforth ICM) aimed to debate the mechanisms of language control in bilinguals. Two predictions of the ICM model are crucial for the present study: 1) lexical selection is competitive within and across languages; and 2) the selection of a lexical entry in one language is obtained by inhibiting lexical competitors in the other language(s) via external task-schemas (Green, 1998, p.69) such as "name the object in language A". The author questioned how to make sure that an individual performing a speech production task requiring the selection of a word in his L1 will establish the right association between the target lemma and its lexical concept in order to control the output goal. This process is achieved through an inhibitory mechanism of language control.

The mechanism of lexical selection in the model consisted of three features, and its locus is at the lemma level (Green, 1998, p. 71). The first one is the presence of language tags. As the author reports, lemmas are specified in terms of a language tag which is also part of the conceptual representation. A lemma has connected tags either for L1 or L2, and tag specification affects the lemma selection process.

The second feature is the suppression (inhibitory control) of lemmas with incorrect language tags in order to control the output goal. For example, translating a word in L2 would activate the lemma having an L1 language tag, which has the incorrect tag, in this case, possibly sharing the properties with the concept in L1. For the L2 lemma to be selected, the activated L1 counterpart must be suppressed.

The third and final feature derived from Levelt et al. (1999) was the matter of lemma selection, also known as the binding-by-checking pattern. This process represents the mechanism in which lemma selection is achieved by checking whether the activated lemma node is linked or not to the correct lexical concept at one level, namely at the phonetic encoding. Here the lemma will be selected adequately because the links between the lemma and its segments correspond with the syllable positions previously assigned to these segments during phonological encodings, such as the onset of the syllable. In short, the process first checks if the link between lemma and segments are correct and then binds this network. This process makes sure that, in a picture-naming task with auditory word distractors, for instance, subjects will not produce any speech errors. More specifically, if a subject sees the picture of a king so the task requires the elicitation of the lemma 'king' and at the same time the subject listens to the word distractor 'pig', he will not produce speech errors such as *ping* because the binding-by checking process avoids this error.

By applying these three factors to ICM's predictions, the selection process both suppresses lemmas with incorrect tags and checks that the activated L1 lemma is connected to a related L2 lemma. Lexicon external task-schemas regulate these two processes, for instance asking subjects to translate from L2 to L1. These schemas drive the inhibition of items possessing a language tag of the unintended language.

However, what is the cost of this process? Time might account for the answer. Therefore, the author reported that language switching requires time because this entitles a change in the 'language schema' according to the task. Moreover, language switching involves the inhibition of prior language tags.

If this hypothesis was correct, then the CSI should not be found in bilingual contexts because of language inhibition via language tags. That is, the inhibitory effect that generates time costs for lexical selection in bilingual contexts should block the mechanisms responsible for the CSI effect.

1.3.2 CSI in bilingual speech production

The study of Runnqvist et al. (2012), crucial for the present study, aimed to test whether the ICM assumptions in Green (1998) were valid in an experiment involving a cross-language continuous naming task (to investigate the relationship between language selection and language control).

With the intention to shedding light on ICM predictions, the authors designed five experiments: 1) within-language CSI assessment in language invariant naming; 2) CSI in alternating language context; 3) CSI in language invariant context (but with a different design); 4) replication of Experiment 2 but with semantic category counterbalancing; 5) similar to Experiment 4 both half of participants named in L1 and half in L2.

Experiment 1 aimed to replicate the study of Howard et al. (2006) and apply it to L1 and L2. A total of 48 Spanish-Catalan bilinguals were tested. The experiment tested two groups of participants: one consisted of 24 Spanish L1 speakers (L2 Catalan), while the second one consisted of 24 Catalan L1 speakers (L2 Spanish). As in the reference study, the experiment consisted of a continuous picture naming task with a 5x24 design. This design means that every semantic category presented is comprised of 5 target items (pictures). Between target items, there were two unrelated intervening items (lags) which could be either target items of a different semantic category or fillers. Results showed a significant effect of trial number and ordinal position (thus CSI effect) regardless of language dominance (L1 or L2).

Experiment 2 aimed to investigate the CSI effect in an alternating language condition, namely semantic categories were presented with target items alternating between L1 and L2. This experiment was crucial for testing ICM assumptions. According to the ICM, CSI would not be expected to survive in this context because of the lexicon external task-schema. The design of this experiment was different compared to the previous one. More specifically, there were ten target items from ten semantic categories for a total of 100.

Moreover, 209 fillers were added to the 100 target pictures. Colours regulated language switching: within one semantic category, five target items had a red coloured frame (L1

Spanish), and the other five target items had a blue coloured frame (L2 Catalan). Results showed that there was a significant effect of trial number and ordinal position (CSI effect). The same effect was also found in L2 responses as well. This effect in L2 responses implies that when subjects have to switch from L1 to L2, naming latencies will get gradually slower according to the ordinal position.

Experiment 3 aimed to compare the CSI magnitude of Experiment 2 with the one expected to be found by running a language invariant task, keeping the same design of the previous one. This time, participants were told to ignore the coloured frames because half of the participants had to name pictures in L1 and half in L2. Also, in this experiment, the CSI effect was present as a function of ordinal position. Because participants were slower in L2 picture naming, it was confirmed that the CSI effect is indistinguishable across investigations.

A combined analysis testing the significance of the factors in Experiment 2 and 3 showed that participants' naming latencies were faster in the latter. This result implicates that language switching affects reaction times (RT), resulting in slower naming latencies. However, these results are not in line with the ICM view, which stated that the semantic competition effect should be reduced or even absent in a language-alternating context.

In order to identify the origin of CSI in language alternating naming contexts, the author designed Experiment 4, which was similar to Experiment 2. What differed here was the target items presentation. In contrast to Experiment 2, where ten target items were alternating between L1 and L2, Experiment 4 had half of the test items corresponding to language A and one semantic category and the other half corresponding to language B and another semantic category. For example, five target items from category 'Vehicle' had to be named in L2, and five target items from category 'Bird' had to be named in L1. Also, in this experiment, results showed a significant effect for both ordinal position and language.

Finally, Experiment 5 attempted to create a new baseline for the analysis due to the new stimuli design. In this experiment, half of the participants named the stimuli in L1, and the other half named them in L2. Results showed that the CSI effect was still present. However, there was no significant effect of the language variable. Combined analysis for significance testing showed that between Experiment 4 and Experiment 5, there was a significant effect of ordinal position as a function of language. The results of the study of Runnqvist et al. (2012) are summarised here below:

- Experiment 1 showed that the CSI effect is similar in both L1 and L2.
- Experiment 2 tested the magnitude of CSI effects is an across-language condition.

- Experiment 3 tested the CSI effect magnitude in a within-language condition reporting similar results to the previous experiment.
- CSI effect magnitude is not affected at all by language switching (Experiment 2 and 5)
- There is a cross-language accumulation.
- CSI is not affected by both language membership and language alternation.

Thus far, the mechanism of lexical access and the semantic context effects of various speech production tasks (e.g. continuous naming, blocked-cyclic naming, or picture-word interference) on this process, have been discussed. The cumulative semantic interference effect has shown particular components that are worth examining at a deeper level.

1.4 The present study

1.4.1 Aim

The present study aims to provide more insight into the lexical access process in speech production, and it will focus on the cumulative semantic interference effect.

As discussed previously, the CSI effect has two critical properties. First, in contrast with the ICM hypotheses, the CSI effect persists in across-language conditions (Runnqvist et al., 2012). Second, it is present and transferred in a joint naming task when participants are listening to the produced target item naming responses of the task partner (Hoedemaker et al., 2017). We do not know, however, what the implications of semantic context effects are if we create a condition combining these two findings.

Thus, the present study will take into account the findings from the works of Runnqvist et al. (2012) and Hoedemaker et al. (2017), testing them with a modified version of the continuous naming paradigm which merges within one single task both a speech production and a comprehension task. This modified paradigm has three essential properties: continuous naming, cross-language processing, and a cross-modality manipulation. In short, the paradigm would be expected to work in a way that participants will be continuously naming a set of semantically-related pictures in Italian (L1), and they will also be hearing a set of semantically related words in Indonesian (L2) from various semantic categories and all mixed together. The first modality of presentation consists of the naming of four semantically-related pictures in the L1, while the second modality consists of hearing three words in the L2 and naming one picture in the L1, all semantically related. So, the paradigm sees a continuous object naming alternating in language and modality during the items' presentation.

1.4.2 Research question

The origin of the CSI effect remains unclear. As discussed in the previous paragraphs, it is very likely that its origin is located at the conceptual level in which multiple related conceptual features are activated via a spreading interactive activation process until exceeding a threshold for the most likely concept according to the visual representation. Finally, it comes into effect at the lexical level in which a lexical concept and its lexical representation are activated.

Critically, according to this view, the CSI effect should be present in an alternating language condition. Therefore, it should have the same magnitude of a language invariant condition, and it should be present across modalities.

The account predicts that in an alternating language context, the presence of this interference effect in such conditions should be due to the fact that once the threshold is exceeded, during lexical selection, by inhibiting the competitive features for the activation of the lexical target, both the L1 and the L2 lexical concepts are co-activated. This generates a language competition that will be resolved by inhibiting the unintended lexical concept via the additional not-matching language feature.

Furthermore, the account predicts that the semantic-to-lexical mapping in lexical retrieval takes place in the same way regardless of whether a word is produced or simply heard. This directly addresses the interference expected to be found in an across-modality condition. In this case, the CSI effect is transferred from one modality to the other.

No previous experiment has combined modalities and (unrelated) languages within one task. Combining these two patterns within one experimental task should shed further light on how lexical and conceptual processing work.

Hence, the research question of the present study is as follows: Does cumulative semantic interference effect persist across languages and across modalities?

1.4.3 Hypotheses

The present study makes three main predictions, which are:

- There is an effect of the ordinal position of trials reflected in a gradual slowing down in the reaction times of the naming latencies.

- The CSI effect persists across modalities. That is, the two modalities of presentation (visual or mixed with auditory stimuli) should show similar naming latencies and hence similar effects of ordinal position.
- The CSI effect persists across languages despite different modalities of presentation (from auditory L2 stimuli to L1 picture naming). That is, across two unrelated languages lacking cognates (Italian and Indonesian), equivalent naming latencies should be found.

Before discussing the predicted hypotheses, the design of the present study will be briefly explained in order to understand how these three predictions will be investigated.

In the experiment, the participants (late Italian-Indonesian bilinguals) will be presented a series of four items from several semantic categories. Of these items, some are pictures that participants have to name in Italian, while others are auditory words in Indonesian, which will be passively listened to by the participants. Some semantic categories will present four pictures to be named in Italian, and some semantic categories will present three auditory words in Indonesian and one picture to be named in Italia. The four items will not be presented sequentially, but they will be distanced from each other by other intervening items belonging to other semantic categories which follow the same design. After that, I will compare what happens in a standard CSI condition (picture naming in Italian across four ordinal positions) with what happens when the first three pictures with passive listening to the spoken Indonesian translations of those pictures are substituted.

The results will be interpreted in the context of a revised model based on Belke (2013), see *Figure* 7.

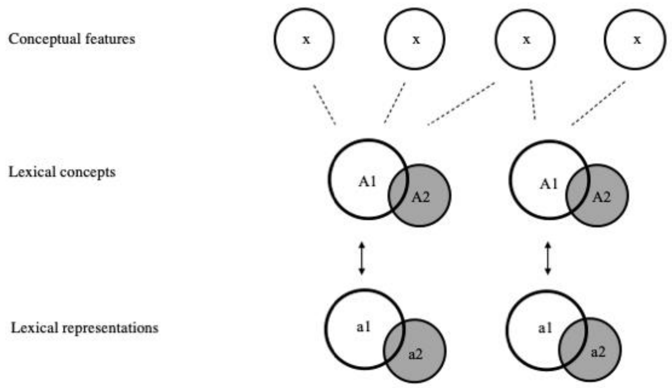

Figure 7: Revised structure of the Conceptual Accumulation account of Belke (2013)

The model shows, at the first level, the multiple shared conceptual features of lexical concepts ('x'). At the second level, lexical concepts ('A1') of the L1 are linked to the lexical representations ('a1'), and the same link applies to the L2 ('A2' and 'a2') as the L2 language relies on the L1 via an interlanguage connection (Kroll and Stewart, 1994). The model assumes that the conceptual features are also shared across languages. The repeated activation of conceptually-related representations generates a conceptual accumulation that delays target lexical selection and yields an inhibitory semantic context effect, as in Belke (2013). Once the threshold is exceeded by inhibiting the competitive features for the activation of the lexical target, both the L1 and the L2 lexical concepts are co-activated (in grey), generating a language competition which will be resolved by inhibiting the unintended lexical concept via the additional not-matching language feature.

If the CSI effect is modality independent, this would mean that the magnitude of the CSI effect is equal whether a participant needs to name a set of four pictures of a given semantic category or to hear three auditory words and naming one picture. Thus, there is a transfer of interference from listening to picture naming. Moreover, the mixed type presentation (auditory and visual stimuli) adopted for this study also includes language as a factor. The auditory stimuli are only presented in L2 (Indonesian) to the subjects. Only when it comes to the visual target item do the participant needs to switch from an L2 comprehension processing status to an L1 speech productive one, to name the presented picture. Thus, the expected finding would infer that the magnitude of CSI effect in the naming latencies of the last item in the visual-only presentation (consisting of 4 pictures of a given semantic category) and in the last item in mixed presentation (consisting of 3 auditory words and 1 picture of a given semantic category) are equal. Having similar results in both types of presentation would implicate that there is a systematic difference between a comprehension induced and production induced CSI effect. This finding would, in fact, answer the final question reported in Hoedemaker et al. (2017, p. 61) specifically regarding the systematic difference in modalities of the CSI effect. The findings would also implicate that the semantic-to-lexical mapping in lexical retrieval while hearing the names of the objects in the mixed presentation would occur similarly to the visual-only presentation, which is in line with the results in Hoedemaker et al. (2017). Lastly, if these results were true, then they would be in contrast with what was reported in Levelt et al. (1999, p. 11), which argued that the semantic effects (and CSI is one of them) are "*obtained only when the task involves producing a verbal response*".

2 Methods

2.1 Unexpected changes in the current study

With the COVID-19 outbreak in February 2020, researchers and students had to change their academic plans. In Italy, all academic institutions were shut down for two months. In the meantime, education was carried out online via video conference calls between students and teachers. Travelling within Europe was highly discouraged. As a consequence, the current study had to change direction and adapt itself to the current risks and possibilities.

This section summarises both the work that was actually done and what was planned but not able to be executed. In the following paragraphs, there will be actions expressed in the past tense representing what has been truly done for the present study. Therefore, all the actions expressed in the conditional tense represent what was planned but no longer possible to do as a result of COVID-19 restrictions and the logistical problems posed by them.

Because it was not possible to have participants to measure reaction times, a source of data from a previous study (Garg et al., in preparation) containing similar stimuli was used. Reaction times from that study were used to create output files respecting the current research design. This provided an example of how the output files would have looked like if the experiment had been run. All the statistical analysis performed are therefore merely representative, and no inferences can be drawn from them with respect to the predictions stated in the previous section.

The two validation tasks, namely the memory and the translation tasks, were not included anymore due to the lack of participants but are described as they were planned to be performed.

What did remain the same was the design of the continuous naming task. For example, the number of lags between target items of the same semantic category was the same but the source of the reaction times was from a different task in a separate study.

2.2 Participants description and language background

2.2.1 Participants

The pool of participants consisted of 40 Italian Bachelor- or Master-degree's students, aged between 18 and 30, enrolled in the Oriental languages and cultures programme at the

University of Naples "L'Orientale". Students who would have been chosen for the present study have opted to study the Indonesian language in their Bachelor or Master programme.

2.2.2 Language background

Regarding the language background, the students taking part in the experiment were born and raised in Italy, and they have Italian as their first language (L1). At the university, students will be studying two Asian languages. The first Asian language, in this case, Indonesian, is carried on for the entire duration of the Bachelor (three years). The second Asian language, however, is studied starting in the second year until the end of the programme. This Master's programme encourages the specialisation of one Asian language only.

These participants, therefore, have chosen the Indonesian (*Bahasa Indonesia*) language as their primary language in their programme. Furthermore, they have additional knowledge of English as a second language (L2) as this is taught from primary school until (and including) high school.

Indonesian language proficiency is quite variable among the subjects. Most of the third-year Bachelor's students and Master's students have spent at least six months in Indonesia studying the language and attending courses at a local university. Thus it is expected that they are more proficient as a function of a language immersion factor.

At the university, the Indonesian language course consists of two parts: language study and conversational study. Indonesian language study (more specifically its grammar) is taught in Italian, while conversational study (topic-related, vocabulary learning, listening, etc.) is mostly in Indonesian as of the first year. Moreover, language proficiency is assessed by a final-term language exam occurring every year, which is mandatory for admission to the following level.

2.3 Design and procedure

For this study, a protocol and instructions were written in Italian. Participants would have read and signed a standard consent form (also in Italian) from the Donders Institute.

This study consists of one main experimental task and two validation tasks, all to be administered to participants in one single session.

The picture naming task would have taken place in one block, having two alternating types of stimuli presentation (trials) showed in a continuous fashion. One type was characterised by a visual-only presentation (Picture Picture Picture Picture; henceforth PPPP) in which participants need to name 4 picture trials in the L1 (Italian). The second type, namely Word Word Word Picture (henceforth WWWP), consisted of a mixed presentation of 3 auditory trials in the L2 (Indonesian) and 1 visual trial (picture) to be named in L1. These two types of presentation were mixed together in order not to make participants aware of them.

Items belonging to the same semantic category were separated by a number of intervening items (a lag 3 to 5 items) which belonged to other semantic categories. These intervening items could either be members of other semantic categories or could also be fillers. The two following explanatory tables presented below show how this modified version of the continuous naming task is structured according to the type of presentation. Numbers represent the semantic categories (in this case, 'food') and letters the single item belonging to that semantic category. These two tables below represent lists for different participants. Moreover, the semantic category (i.e. *food*) to type of presentation (word or picture) mapping is counterbalanced across participants.

Table 1: Picture naming sequence and lags for category 'food' in 'PPPP' presentation

Sequence	**1A**	2A	3A	4A	**1B**	2A	3A	4A	FILLER	**1C**	2B	3B	4B	5A	FILLER	**1D**
Semantic category	*Food*	*Tools*	*Fruits*	*Clothes*	*Food*	*Tools*	*Fruits*	*Clothes*	*Filler*	*Food*	*Tools*	*Fruits*	*Clothes*	*Sea*	*Filler*	*Food*
Lag	0				3					4						5
Picture name	*bread*				*cheese*					*butter*						*meat*
Response language	L1				L1					L1						L1

Table 2: Picture naming sequence and lags for category 'food' in 'WWWP' presentation

Sequence	**1A**	2A	3A	4A	**1B**	2A	3A	4A	FILLER	**1C**	2B	3B	4B	A	FILLER	**1D**
Semantic category	*Food*	*Tools*	*Fruits*	*Clothes*	*Food*	*Tools*	*Fruits*	*Clothes*	*Filler*	*Food*	*Tools*	*Fruits*	*Clothes*	*Sea*	*Filler*	*Food*
Lag	0				3					4						5
Picture name	*bread*				*cheese*					*butter*						*meat*
Trial	WORD				WORD					WORD						PICTURE
Language	L2				L2					L2						L1

In summary, the main experimental task was characterised by two sets of stimuli (visual to be named in Italian and auditory inputs in Indonesian) having the same items and fillers but different formats.

Regarding the procedure of the main experiment, participants would have had to name as fast and accurately as possible the presented items in a continuous sequence. For the 'PPPP' type of presentation, participants would name the presented pictures of a given semantic category in Italian only, thus in their L1 (see *Table 1*). However, with the 'WWWP' type, participants would listen to three items of a given semantic category in Indonesian, thus in their L2, and name the picture of the fourth item in Italian (see *Table 2*). For example, the semantic category '*pets'* is presented to the participant, and one of the 4 items of this category is *dog*. Thus, the picture of a dog would have been shown and named in Italian as '*cane*', namely in the L1. However, when it comes to an auditory trial, namely a spoken word, from a given semantic category, the participant would only hear it. For example, the semantic category '*tools'* is auditorily presented. Here, the participants would have heard an L2 Indonesian stimulus, '*pemukul*', which means 'hammer'.

Before proceeding to the main experiment, participants would have been reminded to not produce noises such as throat-clearing or humming before naming the presented items or any other unconscious (behavioural) sounds or moving. This is crucial for the coding process of raw data, otherwise, these would have been considered as voice key errors and taken out of the analysis. Moreover, participants would have been informed that, during the task, comments or any other vocal feedback which are not relevant to the items' analysis are not allowed. Also, they would have been asked to name the pictures as rapidly and as accurately as possible and to pay attention to the Indonesian words throughout the task.

Participants would have performed multiple practice blocks (9 in total) before the actual experimental task in order to get acquainted with the procedure until they would have responded correctly, that is:

- Answers were loud and clear, no interfering unconscious sounds, pictures were named in the singular number.
- No feedback or comments when an auditory stimulus was presented.
- The participant respected the timing (no delayed answer).
- The participant performed correctly at least 8 out of 9 practice blocks.
- The participant was asked if he/she feels confident with proceeding to the main task.

The question was: "Are you comfortable with proceeding to the main task?"

Before proceeding to the first item, a visual cue would have been shown on the screen for 500 ms, followed by a blank screen for 250 ms. Pictures would remain on the screen for 2000 ms and followed by a blank screen for 500 ms.

2.4 Continuous naming and listening task

The main experimental task consisted of a modified version of the continuous picture naming task. This task has been modified in a way that would have the insertion of auditory trials within the continuous naming task. It attempted to create a task that merges both speech production and speech comprehension. The present continuous naming and listening task would be characterised by the presentation of picture trials to be named in participants' L1, namely Italian and the listening of auditory trials in their L2 (that is Indonesian) throughout the task.

Twenty unique stimuli lists (technically called input files) were created and counterbalanced across participants following 4 mapping criteria which are listed here below:

- Category-to-type of presentation mapping: the type of presentation was assigned to each of the 36 categories, namely whether it had to be a mixed order (WWWP) or a visual-only one (PPPP). More specifically, semantic categories were numbered from 1 to 36. For instance, *food* was numbered as 1, *tools* as 2, *plant items* as 3, and *fruit* as 4. Afterwards, semantic categories had to alternate between P and W type of presentation. So, category 1 was given P, category 2 was given W, and so on in an alternating way. In total, there were 18 categories presenting a W-type of presentations (three auditory word stimuli and one visual stimulus) and 18 categories presenting a P-type of presentation (four visual stimuli). Following this criterion resulted in a set of unique stimuli lists that differed across participants in their type of presentations. By counterbalancing this order, it was found that a given semantic category alternates, across stimuli lists, whether it was a PPPP or a WWWP type of presentation. In such a way, this systematic variation has ensured the internal validity of the study and avoided unsystematic effects such as order effects which could have influenced results in the outcome variable.
- Ordinal position-to-item mapping: each target item (4) within presented categories (36) was assigned an ordinal position from 1 to 4, which differs in every list. For instance, within the semantic category *food* – possessing 4 target items (*bread*, *cheese*, *butter*, and *meat*) – in list 1, *bread* was ordered as the first item, *cheese* as the second item, *butter* as third, and *meat* as fourth. However, in list 1A, target items of this category did

not have the same ordinal position, but rather a different one, such as *bread* was ordered as third, *cheese* as first, *meat* as fourth, and *butter* as the second. This logic was meant to be employed not only for counterbalancing, such as shuffling the ordinal positions within categories according to the stimuli lists, but also for the analysis in order to look up at the target items RT within one category considering the number of lags. In this way, order of presentation of items has been shuffled for each stimulus list, thus across participants in order that every list presented a unique order of presentation of items and to better control noise and avoid order effects.

- Item-to-type of trials mapping: differently from the category-to-modality mapping, which consisted of assigning to each semantic category a type of presentation, the present mapping consisted of assigning to each trial within presented semantic categories the type of trials, namely whether they are auditory trials (W) or picture trials (P). For example, category 1 (i.e. *food*) would present four items mapped as follows: 1A, 1B, 1C, and 1D. Afterwards, these trial labels were mapped to the modality W or P. For example, in category *food*, *bread* was labelled as 1A and mapped to W modality, *cheese* was labelled as 1B and mapped to W modality, *butter* was labelled as 1C and mapped to W modality, and finally, *meat* was labelled as 1D but with P modality. After that, this mapping has been randomised for each stimuli list generating different distributions (i.e. ADBC, DACB, BDAC, etc.)

2.5 First validation task (memory task)

The first validation task consists of a memory task. In this task, participants would have heard the previous Indonesian set of stimuli (thus spoken words) in one single modality (auditory) still presented to participants as spoken words. This time, participants would have been told to perform an additional task and asked to press a key button on the laptop's keyboard in order to answer whether the given word was present in the previous task or not (yes/no questions). This task would have been composed of forty items in total divided as follows: 20 of the 40 items would have been items already heard in the main task; 10 of the 40 items would have been new items that have not been heard in the main task, but that belonged to the semantic categories of the main task and never showed to participants; 10 of the 40 items would have been brand-new items belonging to different semantic categories and not employed in the main task. More specifically, for all 36 semantic categories (presented in the main experimental task) having 4 target items each, a fifth exemplar to the list in order to be used for this memory task has been added. Thus, from the brand-new semantically-related items list, 10 exemplars have been randomly chosen. In addition, there were 10 brand-new semantically-unrelated items.

This task would have helped to assess whether participants carefully paid attention to the L2 words during the picture naming task or not.

2.6 Second validation task (translation task)

Proceeding with the second validation task, participants would have translated all 44 Indonesian words that have been presented in the naming task from Indonesian to Italian (thus, the direction is from L2 to L1). Test scores would have been retrieved according to how many errors a participant made. For example, by rounding to a tenth, 44 correct translations out of 44 are equal to 10/10. All results would have been expressed in full points.

This task was important for having a reference for language proficiency which would have been used later on in the analysis together with the reaction time outcomes.

As in the previous task, participants would have heard the Indonesian words one by one and then they would have been asked to type in a blank space the correct translation in Italian.

2.7 Stimuli

The stimuli employed for the first task are made of a set of 153 items (coloured pictures and spoken words in Indonesian). Of these items, 144 are targets (pairs of pictures and words), and 9 are fillers. From this set, stimuli were divided into two types of presentation: 1) visual-only, which was labelled as 'PPPP' and was characterised by the presentation of four pictures belonging to a given semantic category which needed to be named in the L1; 2) mixed, which was labelled as 'WWWP' as this order predominately presented three L2 auditory items and one visual item belonging to the same semantic category. From this presentation, only the pictures needed to be named in L1.

Each semantic category was composed of 4 target items. All pictures were imageable and sized 650x400 pixels.

Regarding the word item selection, any type of cognates (between Indonesian and English and between English and Italian) have been excluded in order to avoid a cognate effect. Also, Indonesian-Italian cognates were avoided in the item selection process. The set of items (in the form of a word list) would have also been translated in Indonesian and recorded in an isolated room together with an Indonesian native speaker in order to get the auditory stimuli set.

As for the selection of target items for the experimental task, some of the pictures were selected from a set of stimuli previously employed in a different picture naming experiment (Garg et al., in preparation). The remaining ones were selected through an online search and double-checked with a supervisor in order to ensure that the picture would be properly named according to the content. This criterion was kept in mind primarily in order to avoid errors in the naming process throughout the task. For instance, if the category 'sports' is presented and there is a picture of a boxer while training with the punching bag, it is not certain the participant will name it 'boxer'. Therefore we run into the risk that participants will name it 'punching bag' or 'boxing gloves' instead. Consequently, a naming error would occur in the analysis because the picture did not properly represent the expected naming of the item. So, to make sure that the pictures selected during the creation of the stimuli apparatus corresponded to the expected naming, a picture naming agreement survey was administered to some Italian participants. More details regarding the picture naming agreement are reported in the following section.

Stimuli for the second validation task (the memory task) consisted of auditory items which would have been recorded together with the items aimed to be employed in the main experimental task. These stimuli were 40 spoken Indonesian target items in total. Of these, 20 items were part of the previous stimuli set; more specifically, these were 20 randomly-chosen items coming from the previously presented Indonesian words and employed during the main task. Then, there were 20 brand-new items, of which 10 were related to the semantic categories employed in the main experiment but never shown in the experiment, and they were not semantically-related.

Finally, the third task – a.k.a. the translation task – was characterised by 44 Indonesian words auditorily employed in the main experiment.

The experiment, as well as the two validation tasks, would have been presented by using Presentation® on a Windows laptop.

2.8 Picture naming agreement

In order to validate the stimuli selection, namely whether the selected picture corresponded to the correct picture naming, 28 participants took part in an online picture naming agreement survey created with LimeSurvey. The instructions were in Italian, and in order to get a valid response, the participants were told to answer the question "What is it?" when a picture appeared. Participants needed to name all 153 items employed for this study. Items were presented as pictures, and participants wrote the name in an empty response box below the presented picture.

Of these 28 tests, 3 were incomplete. This meant that these participants in particular closed the test before the end. One test was excluded because the participant did not perform the task correctly.

Regarding the naming agreement of the stimuli, 65.56% of the answers did not have full 100% naming agreement. Items with the lowest naming agreement (equal or less than 50%) are: stove (16.7%); guinea pig (29.9%); mouth (37.5%); water (41.7%); church (50%); fire (50%) (see *Appendix* 1 for the complete results).

Different responses according to the original stimuli were checked using an Italian (official) online dictionary, Treccani, in order to check whether the response was an actual synonym or not, such as in the case of 'baby': 1) *bebè* (French-root word); 2) *neonato* (new-born); 3) *infante* (Spanish-root word); or in the case of 'dress': *vestito* or *abito.* Thus, synonyms were counted correct with respect to the shown picture (e.g. in the case of 'dress'). However, words that were not synonyms were treated differently. For example, the picture of a cucumber received 87.5% naming agreement because three participants named it 'courgette'.

Words with a naming agreement lower than 50% would have been excluded from the stimuli. Thus in this case, only 4 items would have been excluded.

2.9 Data pre-processing and analysis

2.9.1 Pre-processing steps

Before retrieving data for the analysis, the RTs were analysed using Praat. Audio files were imported in Praat for their segmentation (onset marking). The onset marking was made following two steps: 1) running an automatic segmentation script; 2) adjusting the onset of the word's articulation by hand using a visual inspection of its spectrogram. After marking the onset of the naming responses, RTs of target items were exported and plugged into an output file comprising: stimuli list, semantic categories, modalities, ordinal positions, accuracy, and RT.

2.9.2 Statistical analysis

In the first section, three predictions were reported in relation to the research question. The first hypothesis predicts that there is a cumulative semantic effect in the naming of the items of a given semantic category. It predicts that there is an effect of ordinal position by the number of trials reflected in a gradual slowing down in the reaction times of the naming latencies. In order to test the first prediction, it was necessary to analyse only the first level of the predictor Type of presentation, specifically the visual-only type of presentation. The analysis took into account naming latencies of picture trials in the PPPP type of presentation according to the ordinal positions within semantic categories. More specifically, it analysed the response of the second item of a given semantic category (e.g. 'cheese' for category 'Food'), compared to the first item, which triggers the first semantic-related RT slowing visible in the second one, following the comparison of the naming latency of the third item (e.g. '*meat*') of the same given semantic category to the second one, and finally, the response latency for the fourth item compared to the third one. The reaction time of the first picture (P_1) was compared to the second (P_2), to the third (P_3), and to the fourth picture (P_4) of a given category in order to check whether there was a gradual slowing down of the naming latencies as a function of ordinal position.

The second hypothesis predicted that the CSI effect persists across modalities. In order to test this prediction, the analysis took into account both levels of the predictor Type of presentation. Specifically, the fourth item (P_4) of the PPPP type of presentation compared to the fourth item (P_{4W}) of the WWWP one. The aim of this analysis was to investigate whether there were any relevant differences in the reaction times as a function of modality. A paired-sample *t*-test (also called dependent *t*-test) was performed in order to test whether the RT means of the two types of presentation differed significantly as a function of modality or not.

The third hypothesis predicted that the CSI effect also persists across language despite different modality of presentation (from auditory L2 stimuli to L1 picture naming within one semantic category). The previous analysis was aimed to analyse a cross-modality effect in the naming latencies. However, the mixed type of presentation (auditory and visual stimuli) also include language. The results of the mean of (P_4) and (P_{4W}) in the previous analysis were also interpreted with this perspective in order to prove that the prediction was valid. Moreover, the size of the CSI effect in a mixed type of presentation could be modulated by L2 proficiency. This modulation could take place in either direction; namely, CSI could be due to either a low proficiency and a high proficiency in the L2. A correlation test would have been performed by plotting the scores of the translation task (i.e. the second validation task) per subject against his or her mean RT in the P_{4W} condition.

Furthermore, a simple linear regression analysis testing the relationship between one outcome (RTs of mixed type of presentation) and the second level of predictor (WWWP) Type of presentation was performed. In short, in order to predict how fast participants were in their reaction times according to the type of presentation, a linear model was fitted to data and used for predicting values of the outcome variable from one predictor variable. In addition to the linear regression analysis, a descriptive statistic for reporting the collective mean and the standard deviation of RT was also performed.

3 Results

3.1 Preface

In light of the changes to the current project mentioned in *Paragraph* 2.1, this section will show how I would have tested my hypotheses about the CSI effect if it had been possible to collect the data.

Starting from the research design shown in Chapter 2, items and semantic categories were substituted with those employed in another picture naming task (Garg et al., in prep.). The rest of the experimental design was kept the same. Lastly, I used actual RT data from the cited study treating it as if it were data that had been collected in my study. Data were assigned randomly to the conditions of the present design, which means that no specific RT data was assigned to a specific item within a semantic category.

3.2 Results

3.2.1 Accuracy

The incorrect picture naming responses were coded as 0, while the correct answers were coded as 1. The RT data were filtered prior to the analysis such that only correct responses were included. Late responses (above 2000 ms) and voice key errors (naming hesitations) were also excluded.

3.2.2 Reaction times in within-modality analysis

The analysis performed here aimed to examine the effects of ordinal position within semantic categories on naming reaction times. Data from all four ordinal positions in the picture-only (PPPP) condition were used. Graphical results of these effects are shown in *Figure 8* below. The X-axis presents the ordinal positions of items within semantic categories, while the Y-axis the mean of the RT in milliseconds.

A one-way ANOVA testing number of ordinal positions (continuous predictor with four levels: 1, 2, 3, 4) by RTs per ordinal position was performed. There were no differences across conditions in the variance (Levene's test not significant). Results showed that there was no significant effect of ordinal position on RTs, $F(3, 56) = .211$, $p = .888$. Tukey HSD post hoc tests (multiple comparisons of the means between the four levels) showed no significant effects.

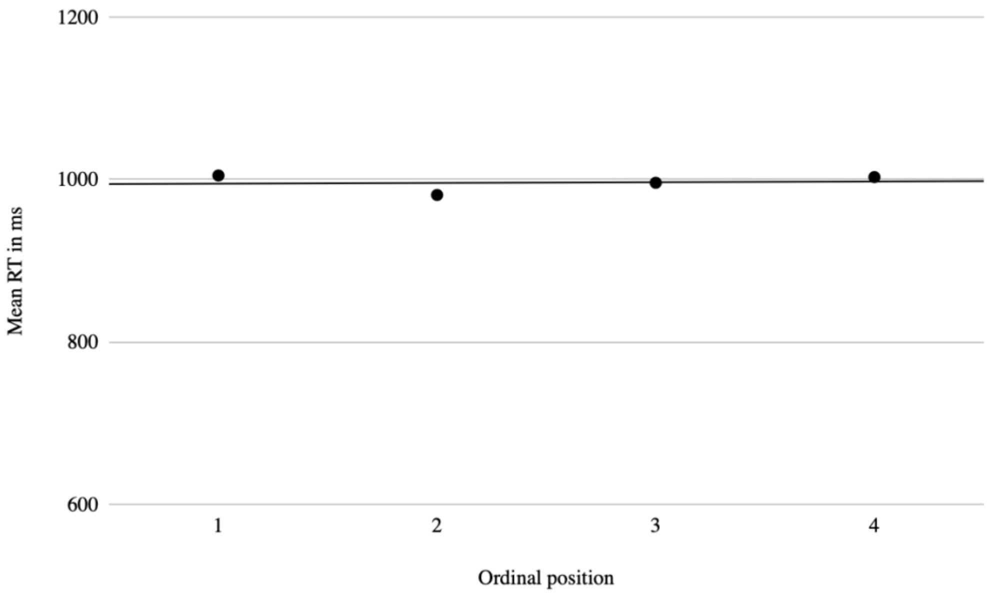

Figure 8: The effect of ordinal position within categories on naming reaction time in the PPPP condition

3.2.3 Reaction times in across-modality analysis

This analysis investigated the effects of the fourth ordinal position within semantic categories on naming reaction times across modalities by comparing responses to the last items from the picture-only condition with those to the last items from the mixed-modality condition.

As shown in *Figure 9*, the frequency distribution of the naming of the fourth items (P4) in the picture-only condition was not normally distributed. In contrast, the frequency distribution in P4w (*Figure 10*) items for the mixed-modality condition was negatively skewed.

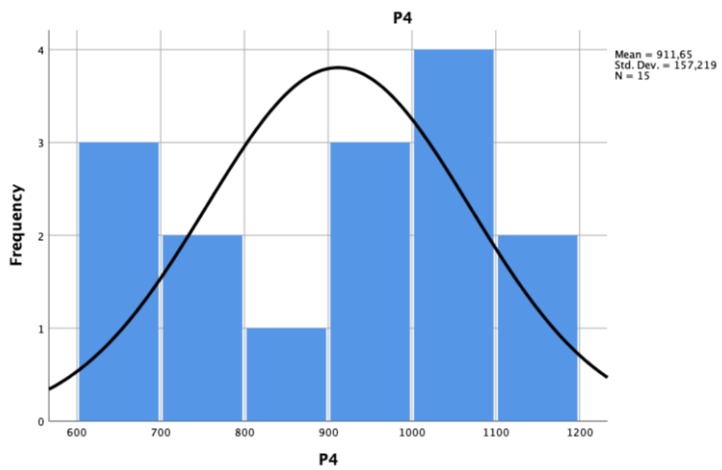

Figure 9: Frequency distribution in the picture only (PPPP) condition

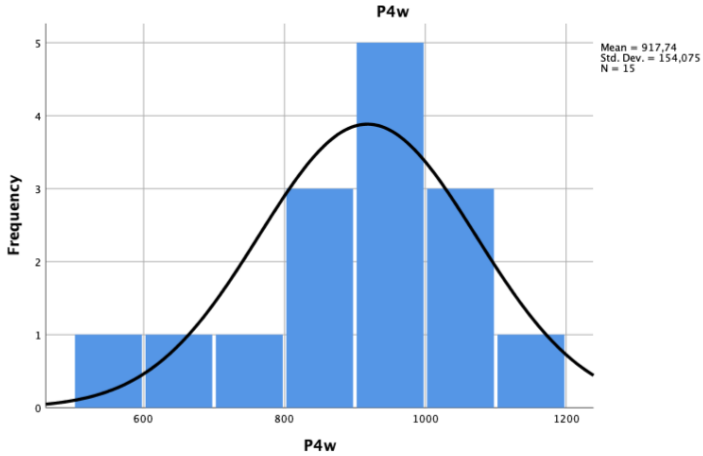

Figure 80: Frequency distribution in the mixed modality (WWWP) condition

A paired-sample t-test was performed analysing the difference in the RTs between those to the fourth named items in the picture-only condition (P4) and those to the pictures in the mixed-modality condition (P4w).

Results showed that the mean difference, -6 ms, 95% CI [-55, 43], was not significant $t(14) = -.268$, $p = .793$. The effect size was small $d = .12$.

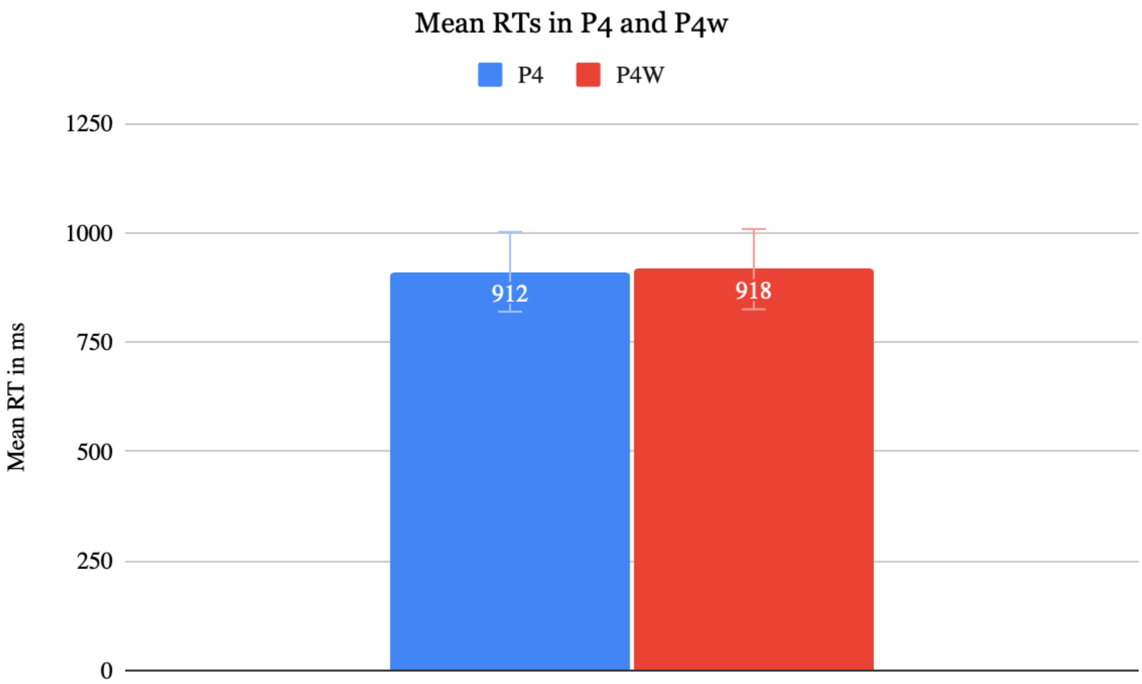

Figure 11: Mean RTs in P4 and P4w conditions

As the assumption of normal distribution was violated in both conditions, a non-parametric test was also performed. A Wilcoxon signed-rank test showed that reaction time of

P4 in picture-only condition did not differ significantly from that of P4w in mixed-modality condition, $T = 63$, $p = .865$.

4 Discussion

The results shown in the previous section are fictional and serve only to show how the data would have been analysed if they had been collected. Thus, the following section will discuss the expected results in the eventuality that the experimental task was performed.

4.1 Expected results

Beginning with naming latency results from the main experiment, a significant effect of ordinal position on RTs would have been expected in the picture-only modality of presentation. More specifically, results would have shown a gradual slowing down visible in the reaction time from the naming of the first target item of a given semantic category tol the last target item of the same category. The factors of language and modality would not bring any significant results in comparing picture-only and mixed-modality conditions, as the language production was targeted on the L1, and it is assumed that the CSI effect persists across languages and modalities. More specifically, the comparison of the reaction times between (P_4) and (P_{4W}) would lead to similar results as participants only hear L2 target items and produce (recorded) feedback in the L1. In this scenario, it could be assumed that the cognitive accumulation occurring from the first target item onwards, whether visual or auditory, was not subject to modality or language. Instead, it resulted from a modality- and language-general competitive process that affects members having similar conceptual features.

Regarding error rates, a relatively low probability of error in the L1 language production would have been expected. This prediction is also supported by the results shown in the picture naming agreement task.

In summary, two major expectations should be outlined. First, the CSI effect is expected in the picture-only (PPPP) condition. Second, if the CSI effect is the result of a lexico-semantic process which is modality general and does not depend on the language (L1 vs L2), there would be no RT difference between responses to the last item in the picture-only condition (P_4) and the last item in the mixed-modality (WWWP) condition (P_{4W}).

4.2 CSI effect by ordinal position

The first hypothesis in the present study, based on the Cumulative Accumulation account (Belke, 2013), stated that the lexical retrieval of a specific item in the picture naming task gets delayed because of the competitively activated shared conceptual features from the previously named items, also in a bilingual context. This delay gets more robust as a function of the number of previously semantically-related items named by the subject. According to this account, the CSI effect should be situated not at the lemma level but the conceptual level. In short, the mechanism of lexical selection is a competitive process that reflects itself in the final output (naming of a picture).

As for the theoretical implications, if the results would have shown an effect of ordinal position on reaction time, this would mean that semantic priming is cumulative according to the previous semantically-related stimulus (thus in line with Howard et al., 2006; Schnur, 2014; and in the language invariant condition in Experiment 2 of Runnqvist et al., 2012). In addition, such a conclusion would indicate that there is an inhibitory semantic context effect, and it would, in turn, support the competitive nature of lexical selection stated in Belke (2013), which affirms that the repeated activation of conceptually-related representation (e.g. naming members of the same semantic category) generates a conceptual accumulation which delays target lexical selection.

However, it is possible that the predicted outcome cannot be observed, implicating that there would be no effect of ordinal position.

This possibility would, in turn, mean that – with the employment of the current research design – there is no additional slowing down of the naming latencies by ordinal position within semantic categories. However, this result contrasts with the reviewed literature presented in the Introduction (Howard et al., 2006; Runnqvist et al., 2012; Belke, 2013; etc.). In this case, such a conclusion would implicate that there is no inhibitory semantic context effect, and it would, in turn, question the competitive nature of lexical selection.

4.3 CSI effect across modalities

The second hypothesis stated that the CSI effect's magnitude is equal whether a participant needs to name a set of four pictures of a given semantic category or to hear three auditory words and name one picture. Thus, the CSI effect would persist across modality as there is a transfer of interference from listening to picture naming.

Theoretically speaking, such results would mean that both the activation of the lexical concepts (and their related lexical nodes) by hearing three exemplars of a given semantic category and the shift from a comprehension task (three sounds) to a speech production task (picture naming of the fourth item) would have an influence on the final selection of the target lemma to name the presented picture.

Supposing such results would not be visible with the employment of the current design. In that case, it should be assumed that within a given semantic category, the picture naming of the last item after previously hearing three semantically-related exemplars is the product of a non-cumulative semantic interference.

More specifically, this would mean that the transfer of interference from listening to naming would therefore not present. So, such results would, in turn, question the design itself with regards to the findings reported in Hoedemaker et al. (2017) to investigate the key factors showing this unexpected result.

4.4 CSI effect across languages

The third hypothesis stated that having the CSI effect in a cross-language task would indicate that language alternation and selection according to the task do not affect the final output (picture naming). The language alternation condition would cause participants to be slower when they name the last targets in Italian after hearing semantically-related exemplars in Indonesian. So, language would operate as a competitor in the lexical selection and switching continuously from Indonesian to Italian would therefore affect the final output due to a language competition process.

In this view, such a result would infer that the shift from an L2 comprehension task to an L1 speech production task would interfere with lexical selection generating a semantic accumulation and slowing down the response latencies of the L1 picture naming of the last items. Also, back to the revised model proposed in the introduction section, such a result would support the theory about a simultaneous activation of lexical concepts in both the L1 and the L2. As stated in the introduction, this simultaneous activation would generate a language competition that needs a threshold to be exceeded by inhibiting both the competitive features for the activation of the intended lexical target and the unintended lexical concept via the additional not-matching language feature.

However, if the CSI would not be visible in the present study, then the final interpretation would postulate that also the shift from the comprehension of an L2 word to the production of an L1 word does not interfere with lexical selection, which in turn means that the CSI effect is not found in such experimental condition. The reasons could be numerous. Perhaps, in this alternating language condition, the CSI effect was not found because of the comprehension task. So, would it be the case that word comprehension activates lexical concepts and lexical items differently from word production?

If the alternating language condition would have consisted of a word production task only, thus naming three pictures in the L1 and the last item in the L1, would the results have differed with respect to the current ones?

Results would be entirely in contrast with Experiment 3 in Runnqvist et al. (2012), in which language alternation causes participants to be slower than when they name targets in one language only. In regards to the present study, the mean of the naming reaction time in P4w would be higher than that in P4.

Back to the lexical retrieval process, if the language does not operate as a competitor in the lexical selection, then the postulation reported in Runnqvist et al. (2012: 864) stating that the intended word is selected via a language inhibitory process ensuring the lexical selection in the intended language would not be in line with the findings reported.

4.5 Perspectives for future research

In light of the circumstances that affected the present study's realisation in terms of data collection and performance of the experimental task with actual subjects, the following paragraph will discuss future research on this topic.

Starting with the theoretical aspects, the first topic that needs to be investigated is exactly that discussed in the present study. The actual experimental task needs to be performed by keeping the current design in order to investigate the hypotheses stated in the previous sections.

Another interesting point that could be examined is an additional experimental condition of the first study by adopting the same research design for a group consisting of simultaneous bilinguals of two related-language (e.g. Dutch-English) if the first study would show no CSI effect. Perhaps, performing such experimental condition with related languages would show a greater magnitude of the CSI effect, and the results of the experiment would then be more informative compared to the results obtained from the previous study (on Italian-Indonesian), which investigated late bilinguals in order to get more room for further discussion on the mechanism of lexical selection in bilinguals. In addition, it would also be interesting to investigate the late bilingual participants' level of proficiency and age of acquisition of the L2 in relation to the effect of ordinal position within semantic categories. In this case, the following study would investigate the incidence of these two factors might have on the naming latencies. Theoretically speaking, if these two factors would present a positive correlation to the effect of ordinal position across participants, then it could be assumed that the mechanism of lexical access in bilinguals might develop in a staged way across the years in relation to the acquired level of proficiency of the L2, which sort of reminds the revised hierarchical model in Kroll and Stewart (1994).

As for the methodological aspects for future perspective, the experimental task should be performed as it was planned and implemented. First of all, the experimental task still needs to be administered to the participants as we do not have empirical findings regarding the hypothesis of the persistence of the CSI effect in a language and modality alternating condition. Second, two aspects could be added to the current design: 1) the addition of an Italian monolingual control group (with both modality invariant and alternating modality presentations but here the auditory stimuli would be only in Italian); 2) creating a condition in which participants (late bilinguals) also perform a language invariant condition (Italian) by keeping the alternating types of presentation. In this way, one could analyse several aspects, such as:

- The results in the monolingual control group by expecting that the CSI effect occurs in both conditions;
- The results in the bilingual group across the three conditions (modality invariant; modality alternating but language invariant; language and modality alternating) would show a persistent CSI effect which its magnitude is greater in the the language and modality alternating condition than the other two.
- To compare the modality alternating and modality invariant conditions of the bilingual group with those of the control group, expecting that the bilinguals in the modality alternating condition would perform slower due to the co-occurring activation of the L2 lexical concept and lexical item of a given L1 item (see the revised structure of the Conceptual Accumulation account discussed in the introduction section).

The limitations of this study's methodology were as follows. SPSS's limitations for running the reported analysis must be bypassed by the employment of another suitable statistical software (such as R) designed for this type of factorial analysis. R's employment would be useful because the software itself allows performing a mixed-effect analysis by nesting one factor (e.g. *F2*, which would be the semantic category factor) within another one (e.g. *F1*, which would be ordinal position). In this case, SPSS is quite limited as it does treat the variables as related but does not allow them to be nested so that the machine could perform a more specific analysis of the factors (*F1* and *F2*) in relation to the outcome (RTs).

Also, the simulated results in the analysis could be ascribable to practical aspects such as an incorrect onset marking during the data coding phase. It is crucial to mark the picture naming response on the right onset because even a small difference of 10ms is significant in this type of study. Thus, very precise RT measurements, as well as onset marking, are crucial.

5 Conclusion

The present work aimed to examine the cumulative semantic interference effect in Italian-Indonesian late bilinguals.

The investigation of this semantic context effect represented a window for analysing the mechanisms underlying lexical selection in speech production tasks. The review of the current literature on the matter served to explain where and how the cumulative semantic interference effect was found.

Three main hypotheses were formulated for the present study. The first hypothesis predicted that there is an effect of ordinal position on picture naming latencies. Subjects' naming latencies would slow down for each previously named member of a given semantic category. This effect would indicate that there was a cumulative semantic interference for lexical selection by the prior selection of semantically-related exemplars of the same category. The second hypothesis predicted that the cumulative semantic interference effect was present despite the two different modalities of presentation of the items by comparing the naming latencies of the last items of both modalities. The persistence of this effect would then indicate that the interference is transferred across modalities. The third hypothesis proposed that the cumulative semantic interference effect persisted across modalities and across languages via a continuous shift from L1 picture naming to L2 word listening because the two different types of presentations also embedded language alternation between speaker's L2 and L1. Thus, such an effect would still be visible in comparing the picture naming latencies in the two conditions on the last items in the sets of four semantic category members.

The present work's main goal was to add another piece to the lexical selection theories' puzzle. However, this goal has not been achieved given the current worldwide health crisis, which slowed down the writing of this thesis and prevented the main experimental task's execution with actual participants.

According to the research design developed for this study, the data analysis served only to simulate the experimental task results. Thus, it does not allow for any speculations about the cumulative semantic interference effect.

In conclusion, the present study thus represents a proposal for an experiment cumulative semantic interference effect rather than a report of that experiment's outcomes. The actual experiment needs to be carried out to test the predicted hypotheses.

Appendix 1

Appendix 1: Results of the naming agreement task

Stimuli_IT	English_translation	Naming agreement in %
Forno	Stove	16,7
Criceto	Guinea pig	29,2
Bocca	Mouth	37,5
Acqua	Water	41,7
Chiesa	Church	50,0
Fuoco	Fire	50,0
Infante	Baby	54,2
Vino	Wine	54,2
Anatra	Duck	58,3
Vespa	Wasp	58,3
Lucertola	Lizard	62,5
Spremuta d'arancia	Orange juice	62,5
Cucchiaio	Spoon	66,7
Cigno	Swan	70,8
Scarafaggio	Cockroach	75,0
Pepe	Black pepper	79,2
Pannocchia	Corn	79,2
Piede	Foot	79,2
Coniglio	Rabbit	79,2
Montagna	Mountain	83,3
Chiodo	Screw	83,3
Mare	Sea	83,3
Cintura	Belt	87,5
Cetriolo	Cucumber	87,5
Zenzero	Ginger	87,5
Mocio	Mop	87,5
Vicolo	Alleway	91,7
Posacenere	Ashtray	91,7
Barca	Boat	91,7
Castello	Castle	91,7
Cervo	Deer	91,7
Occhio	Eye	91,7
Graffetta	Paperclip	91,7
Aereo	Airplane	95,8
Banana	Banana	95,8
Bicicletta	Bike	95,8
Burro	Butter	95,8
Gallina	Chicken	95,8
Nuvola	Cloud	95,8
Coccodrillo	Crocodile	95,8
Aglio	Garlic	95,8
Fulmine	Lightning	95,8
Quaderno	Notebook	95,8
Arancia	Orange	95,8
Gufo	Owl	95,8
Fucile	Rifle	95,8
Anello	Ring	95,8
Strada	Road	95,8
Squalo	Shark	95,8

Spalla	Shoulder	95,8
Marciapiede	Sidewalk	95,8
Lavandino	Sink	95,8
Asciugamano	Towel	95,8
Trapano	Drill	100,0
Freccia	Arrow	100,0
Ascia	Axe	100,0
Borsa	Bag	100,0
Vasca	Bathtub	100,0
Letto	Bed	100,0
Scatola	Box	100,0
Bracciale	Bracelet	100,0
Pane	Bread	100,0
Farfalla	Butterfly	100,0
Torta	Cake	100,0
Caramella	Candy	100,0
Carota	Carrot	100,0
Gatto	Cat	100,0
Sedia	Chair	100,0
Camaleonte	Chameleon	100,0
Formaggio	Cheese	100,0
Cuoco	Chef	100,0
Peperoncino	Chili	100,0
Sigaretta	Cigarette	100,0
Cocco	Coconut	100,0
Mucca	Cow	100,0
Cane	Dog	100,0
Bambola	Doll	100,0
Porta	Door	100,0
Vestito	Dress	100,0
Orecchio	Ear	100,0
Orecchino	Earring	100,0
Melanzana	Eggplant	100,0
Elefante	Elephant	100,0
Gomma	Eraser	100,0
Occhiali	Eyeglasses	100,0
Pesce	Fish	100,0
Fiore	Flower	100,0
Mosca	Fly	100,0
Forchetta	Fork	100,0
Frigorifero	Fridge	100,0
Rana	Frog	100,0
Bambina	Girl	100,0
Erba	Grass	100,0
Martello	Hammer	100,0
Mano	Hand	100,0
Testa	Head	100,0
Ippopotamo	Hippopotamus	100,0
Miele	Honey	100,0
Cavallo	Horse	100,0
Casa	House	100,0
Ferro da stiro	Iron	100,0
Isola	Island	100,0

Marmellata	Jam	100,0
Tastiera	Keyboard	100,0
Aquilone	Kite	100,0
Coltello	Knife	100,0
Foglia	Leaf	100,0
Biblioteca	Library	100,0
Accendino	Lighter	100,0
Leone	Lion	100,0
Uomo	Man	100,0
Fiammifero	Matchstick	100,0
Carne	Meat	100,0
Latte	Milk	100,0
Specchio	Mirror	100,0
Scimmia	Monkey	100,0
Collana	Necklace	100,0
Naso	Nose	100,0
Infermiera	Nurse	100,0
Polpo	Octopus	100,0
Cipolla	Onion	100,0
Maiale	Pig	100,0
Piatto	Plate	100,0
Pappagallo	Parrot	100,0
Pesca	Peach	100,0
Prete	Priest	100,0
Arcobaleno	Rainbow	100,0
Tetto	Roof	100,0
Sega	Saw	100,0
Sciarpa	Scarf	100,0
Temperamatite	Sharpner	100,0
Conchiglia	Shell	100,0
Gonna	Skirt	100,0
Serpente	Snake	100,0
Calzino	Sock	100,0
Scale	Stairs	100,0
Stella marina	Starfish	100,0
Valigia	Suitcase	100,0
Sole	Sun	100,0
Spada	Sword	100,0
Siringa	Syringe	100,0
Tavolo	Table	100,0
Tigre	Tiger	100,0
Semaforo	Traffic light	100,0
Treno	Train	100,0
Albero	Tree	100,0
Ombrello	Umbrella	100,0
Cameriere	Waiter	100,0
Armadio	Wardrobe	100,0
Lavatrice	Washing machine	100,0
Cascata	Waterfall	100,0
Finestra	Window	100,0
Lupo	Wolf	100,0
Donna	Woman	100,0

References

Belke, E. (2013). Long-lasting inhibitory semantic context effects on object naming are necessarily conceptually mediated: Implications for models of lexical-semantic encoding. *Journal of Memory and Language, 69*(3), 228-256.

Caramazza, A. (1997). How many levels of processing are there in lexical access?. *Cognitive Neuropsychology*, *14*(1), 177-208.

Damian, M. F., Vigliocco, G., & Levelt, W. J. (2001). Effects of semantic context in the naming of pictures and words. *Cognition*, *81*(3), B77-B86.

Garg, A., Piai, V., McQueen, J. M., & Roelofs, A. (in prep.). The comprehension-production interface: Insights from cumulative semantic effects. Manuscript in preparation.

Glaser, W. R., & Düngelhoff, F. J. (1984). The time course of picture-word interference. *Journal of Experimental Psychology: Human perception and performance*, *10*(5), 640.

Green, D. W. (1998). Mental control of the bilingual lexico-semantic system. *Bilingualism: Language and Cognition*, *1*(2), 67-81.

Hoedemaker, R. S., Ernst, J., Meyer, A. S., & Belke, E. (2017). Language production in a shared task: Cumulative semantic interference from self-and other-produced context words. *Acta Psychologica*, *172*, 55-63.

Howard, D., Nickels, L., Coltheart, M., & Cole-Virtue, J. (2006). Cumulative semantic inhibition in picture naming: Experimental and computational studies. *Cognition*, *100*(3), 464-482.

Kroll, J. F., & Stewart, E. (1994). Category interference in translation and picture naming: Evidence for asymmetric connections between bilingual memory representations. *Journal of Memory and Language*, *33*(2), 149-174.

Levelt, W. J., Roelofs, A., & Meyer, A. S. (1999). A theory of lexical access in speech production. *Behavioral and Brain Sciences*, *22,* 1-38.

Roelofs, A. (2018). A unified computational account of cumulative semantic, semantic blocking, and semantic distractor effects in picture naming. *Cognition*, *172*, 59-72.

Runnqvist, E., Strijkers, K., Alario, F. X., & Costa, A. (2012). Cumulative semantic interference is blind to language: Implications for models of bilingual speech production. *Journal of Memory and Language*, *66*(4), 850-869.

Schnur, T. T. (2014). The persistence of cumulative semantic interference during naming. *Journal of Memory and Language*, *75*, 27-44.