Word learning

When associative learning meets social-pragmatic expectations

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English summary

Word Learning: When Associative Learning Meets Social-Pragmatic Expectations

How we associate a new word with its correct referent, or more simply, how we learn new words, has led to a long-standing debate in psycholinguistics. In Chapter 1 of this dissertation, we present two of the main frameworks of word learning that have been put forward: intentional (also social-pragmatic) learning and associative learning. While the former argues that word learning is supported by the social-cognitive abilities of learners that allow them to determine the communicative intentions of their interlocutors; the latter suggests that word learning is possible thanks to the human ability to track the statistical information about the environment (i.e., the frequency of co-occurrence between a word and an object). Given that these two frameworks separate the *learning from whom* from the *learning what*, they do not provide a comprehensive view of the key interactions involved in human language learning. An intermediate approach that bridges the gap between associative and social-pragmatic approaches to word learning, is the communicative/intentional framework. As briefly described in Chapter 1, this approach conceives of word learning as the result of a probabilistic combination of social-pragmatic and statistical cues. These cues are not considered independent of each other, but rather both inform an inference about the speaker's intended referent.

Since the communicative/intentional framework assumes that the rela-

tionship between a word and its referent is mediated by the speaker's intention to refer to a specific (set of) object(s), the studies presented in this dissertation take this assumption as their theoretical backdrop. Two general research questions were posed: 1) how do social-pragmatic cues affect cross-situational word learning?; and 2) when in time do social-pragmatic effects emerge when learning words across situations? To answer these questions, we designed five experiments, which are presented in Chapters 2, 3 and 4, and posed six research sub-questions, which are addressed in each of these chapters.

In Chapter 2, we present the first set of two cross-situational word learning (CSWL) studies. We draw on early word learning research and the finding that, when learning from an unreliable speaker (i.e., someone who has made mistakes in naming familiar objects), learners are less likely to associate a new word with a new, unfamiliar object. Therefore, we designed two CSWL experiments in which we presented participants with a reliable and an unreliable speaker while they were asked to learn new words. While a reliable speaker would always map a word to a specific object, an unreliable speaker would sometimes not. We manipulated speaker reliability both within-subjects (Experiment 1) and between-subjects (Experiment 2) to answer the following sub-questions: i) to what extent do adult learners perceive the reliability of the speaker?; and ii) to what extent does speaker reliability influence cross-situational word learning?. The results of Experiment 1 showed that participants were sensitive to the difference in speaker reliability, but learned to the same degree of accuracy from both reliable and unreliable speakers. The results of Experiment 2 showed a similar pattern of results in terms of word learning, but no difference in terms of participants' sensitivity to speaker reliability. To explain these results, we argued that participants may have relied primarily on the co-occurrences between a word and an object. Given that this distributional information was a fairly consistent and reliable cue (i.e., a word co-occurred with the same object 16 times), participants may have processed speaker reliability in less detail or simply ignored it.

In Chapter 3 we adapted the task of Chapter 2 by 1) reducing the number of word-object co-occurrences to two trials, and 2) including a cross-trial manipulation that allowed to examine the effect of speaker reliability on two cognitive mechanisms underlying CSWL, namely associative learning and hypothesis testing. Again, we presented participants with a reliable and

an unreliable speaker, and administered this variable both between-subjets (Experiment 1) and within-subjects (Experiment 2). We asked the following sub-questions: iii) to what extent does speaker reliability affect how learners make new word-object associations across situations?; and iv) to what extent does learners' perception of the reliability of the speaker influence their word learning? Given evidence from similar studies, we hypothesized that participants who learned from an unreliable speaker would be more likely to rely on associative learning, allowing them to store more objects as potential referents for a word. A dependence on hypothesis testing, instead, would be more likely to be observed when learning from the reliable speaker, because there would be no need to consider more than one object as a potential referent for a word. Results for both accuracy and reaction time data showed no significant differences between conditions; i.e., we did not find an association between speaker reliability and the type of word learning mechanism used by learners. In addition, participants' subjective perception of the reliability of the speakers did not affect their word learning behavior.

The results of the experiments in Chapter 2 and Chapter 3 do not support or contradict the hypothesis that exposure to an unreliable speaker results in learning fewer words and/or relying on associative learning. Furthermore, the evidence that participants perceptions of speaker reliability affected their word learning was inconsistent across these four experiments. Based on these results, and the design of these experiments, we noted that our experiments had overlooked a crucial aspect of the learning situation: the communicative intentions of the speaker and the pragmatic inferences made by the word learner. The way we manipulated speaker reliability overlooked these factors because learners were not required to make any inference beyond mapping a word to an object. In other words, they did not need to go beyond the literal meaning of an expression to learn a new word. Therefore, a new experimental design was developed that not only included the speaker's communicative intentions, but also allowed us to measure their effects in a fine-grained manner. To do this, we drew on previous eye-tracking research on the effect of pragmatic inferences on referential resolution. We present this experiment in Chapter 4.

The eye-tracking experiment presented in Chapter 4 was designed to investigate the effect of speaker informativeness on CSWL. We asked v) to what extent does speaker informativeness influence learners' word-object mapping;

and vi) at what point in time do differences in eye fixations to the target object emerge as a function of speaker informativeness? We adapted the design developed in Chapter 3 by testing utterances that contained a noun modified by a prenominal color adjective, such as *The yellow banana*. Prenominal adjectives tend to trigger a contrastive inference that has been proposed to be pragmatic in nature: *the yellow banana* implies that there should be another banana of a different color. As such, a contrastive inference may be suspended in the presence of, for example, an over-informative speaker, who uses the prenominal adjective in a superfluous way (e.g., by uttering *The yellow banana* in a context where there is only one banana that corresponds to such description). This, in turn, may influence the referent to which a learner assigns a new word. We used a 2 x 2 mixed factorial design, which allowed us to test the manipulation of speaker informativeness both within and between subjects. We hypothesized that learning from an non-optimally informative speaker (i.e., a speaker who over-informatively used the color adjective) would lead participants to choose an object that competed with the target object in terms of its color attribute. Learning from an optimally informative speaker, on the other hand, would lead participants to prefer the target object.

We analyzed both target object selection and participants' movements toward he target object. The results of the object selection data showed that participants were less likely to choose the target object in a condition in which one speaker was optimally informative and the other was not, compared to a condition in which both speakers were optimally informative. However, participants in the former condition did not differ in terms of their target object selection as a function of speaker informativeness. To assess whether there was a speaker-related effect, we analyzed participants' eye-tracking data. The results indicated an early effect of speaker informativeness, which occurred before participants heard the linguistic stimuli. Specifically, this effect suggests that speaker informativeness influences initial selection of objects as potential targets. Although this effect is brief, it supports the pragmatic nature of contrastive inferences related to prenominal modifiers, and it highlights the importance of measuring the word learning process as it unfolds over time.

Finally, Chapter 5 provides an overview and discussion of the main findings. In response to our two general research questions, we draw two main conclusions. First, that social-pragmatic information can have an effect on the

way adult learners map a new word to an object, given a learning situation that highlights the speaker's communicative intentions. And second, that this effect may occur early on in the learning process, which can only be observed by means of using sensitive, fine-grained methods, such as eye-tracking.

Nederlandse samenvatting

Woorden leren: Wanneer associatief leren komt samen met sociaal-pragmatische verwachtingen

De vraag hoe we nieuwe woorden leren associëren met hun juiste referent, of eenvoudiger, hoe we nieuwe woorden leren, is het onderwerp van een langdurig debat in de psycholinguïstiek. In Hoofdstuk 1 van dit proefschrift presenteren we twee belangrijke theoretische kaders van woordleren die zijn voorgesteld: intentioneel (ook wel sociaal-pragmatisch) leren en associatief leren. De eerste stelt dat het leren van woorden wordt ondersteund door de sociaal-cognitieve vaardigheden van de leerder, die hem in staat stellen om de communicatieve intenties van zijn gesprekspartners te bepalen; de tweede suggereert daarentegen dat het leren van woorden mogelijk is dankzij het menselijk vermogen om statistische informatie over de omgeving bij te houden, namelijk de frequentie van het samen voorkomen van een gesproken woord en een object. Gezien het feit dat deze twee kaders de context van het leren *van wie* scheiden van de context van het leren *waarvan*, geven ze geen volledig beeld van de belangrijkste interacties die een rol spelen in het leren van taal door mensen. Een benadering die de kloof tussen associatieve en sociaal-pragmatische benaderingen overbrugt, is het communicatieve/intentionele kader. Zoals kort beschreven in Hoofdstuk 1, beschouwt deze benadering het leren van woorden als het resultaat van een probabilistische combinatie van sociaal-pragmatische en statistische signalen. Deze aanwijzingen worden niet onafhankelijk van elkaar beschouwd, maar geven beide

informatie over de bedoelde referent van de spreker.

Aangezien het communicatieve/intentionele kader ervan uitgaat dat de relatie tussen een woord en zijn referent bemiddeld wordt door de intentie van de spreker om te verwijzen naar een specifiek object (of een specifieke verzameling objecten), nemen de in dit proefschrift gepresenteerde studies deze aanname als theoretische achtergrond. We stellen twee algemene onderzoeksvragen: 1) hoe beïnvloeden sociaal-pragmatische cues het leren van woorden over situaties heen?; en 2) wanneer in de tijd treden sociaal-pragmatische effecten op bij het leren van woorden over situaties heen? Om deze vragen te beantwoorden ontwierpen we vijf experimenten, die worden gepresenteerd in de hoofdstukken 2, 3 en 4, en stelden we zes onderzoeksvragen, die in elk van deze hoofdstukken aan bod komen.

In Hoofdstuk 2 presenteren we de eerste reeks van twee onderzoeken naar cross-situationeel woordleren (CSWL). We baseren ons op vroeg onderzoek naar het leren van woorden en de bevinding dat leerders minder snel een nieuw woord zullen associëren met een nieuw, onbekend object wanneer ze leren van een onbetrouwbare spreker (d.w.z. iemand die fouten heeft gemaakt bij het benoemen van al bekende objecten). Daarom ontwierpen we twee CSWL-experimenten waarin we deelnemers een betrouwbare en een onbetrouwbare spreker lieten horen terwijl ze nieuwe woorden moesten leren. Terwijl een betrouwbare spreker een woord altijd aan hetzelfde object koppelt, doet een onbetrouwbare spreker dat soms niet. We manipuleerden de betrouwbaarheid van de spreker zowel binnen proefpersonen (Experiment 1) als tussen proefpersonen (Experiment 2) om de volgende subvragen te beantwoorden: i) in hoeverre nemen volwassen leerders de betrouwbaarheid van de spreker waar?; en ii) in hoeverre beïnvloedt de betrouwbaarheid van de spreker het leren van woorden over verschillende situaties heen? De resultaten van Experiment 1 laten zien dat deelnemers gevoelig waren voor het verschil in betrouwbaarheid van de spreker, maar even nauwkeurig leerden van betrouwbare als onbetrouwbare sprekers. De resultaten van Experiment 2 lieten een vergelijkbaar patroon zien in termen van woordleren, maar geen verschil in termen van gevoeligheid van deelnemers voor de betrouwbaarheid van sprekers. Om deze resultaten te verklaren, stelden we dat deelnemers er mogelijk vooral op vertrouwden hoe vaak een woord en een object samen voorkwamen. Aangezien deze distributionele informatie een vrij consistente en betrouwbare cue was (een woord kwam bijvoorbeeld 16 keer voor

met hetzelfde object), kan het zijn dat deelnemers de betrouwbaarheid van de spreker minder in detail verwerkten of zelfs gewoon negeerden.

In Hoofdstuk 3 pasten we de taak van Hoofdstuk 2 aan door 1) het aantal keer dat een woord en een voorwerp samen voorkwamen te verminderen tot twee trials, en 2) variabelen zodanig te manipuleren dat we het effect konden onderzoeken van de betrouwbaarheid van de spreker op twee cognitieve mechanismen die ten grondslag liggen aan CSWL, namelijk associatief leren en hypothesetoetsing. Opnieuw presenteerden we deelnemers een betrouwbare en een onbetrouwbare spreker, en we dienden deze variabele zowel tussen proefpersonen (Experiment 1) als binnen proefpersonen (Experiment 2) toe. We stelden de volgende subvragen: iii) in hoeverre beïnvloedt de betrouwbaarheid van de spreker de manier waarop leerders nieuwe woorden en voorwerpen associëren in verschillende situaties?; en iv) in hoeverre beïnvloedt de perceptie van de betrouwbaarheid van de spreker het leren van woorden? Op basis van gelijkaardig onderzoek veronderstelden we dat deelnemers die leerden van een onbetrouwbare spreker meer geneigd zouden zijn om te vertrouwen op associatief leren, waardoor ze meer objecten zouden kunnen opslaan als potentiële referenten voor een woord. Daarentegen verwachtten we bij het leren van de betrouwbare spreker eerder een afhankelijkheid van hypothesetoetsing waar te nemen, omdat leerders geen noodzaak zouden zien om meer dan één object als potentiële referent voor een woord te beschouwen. De resultaten voor zowel accuraatheid als reactietijd lieten geen significante verschillen zien tussen de condities; we vonden dus geen verband tussen de betrouwbaarheid van de spreker en het type woordleermechanisme dat de leerders gebruikten. Bovendien had de subjectieve perceptie van de betrouwbaarheid van de sprekers geen invloed op hun woordleergedrag.

De resultaten van de experimenten in Hoofdstuk 2 en Hoofdstuk 3 ondersteunen noch weerspreken de hypothese dat blootstelling aan een onbetrouwbare spreker resulteert in het leren van minder woorden en/of het vertrouwen op associatief leren. Bovendien was het bewijs dat de perceptie van de betrouwbaarheid van de spreker het leren van woorden beïnvloedde niet consistent in deze vier experimenten. Op basis van deze resultaten en de opzet van deze experimenten stelden we vast dat onze experimenten een cruciaal aspect van de leersituatie over het hoofd hadden gezien: de communicatieve intenties van de spreker en de pragmatische gevolgtrekkingen die

de woordleerder maakt. De manier waarop we de betrouwbaarheid van de spreker manipuleerden, zag deze factoren over het hoofd omdat de leerders geen andere gevolgtrekkingen hoefden te maken dan het koppelen van een woord aan een object. Anders gezegd hoefden de leerders niet verder te kijken dan de letterlijke betekenis van een uitdrukking om een nieuw woord te leren. Daarom ontwikkelden we een nieuw experimenteel ontwerp dat niet alleen de communicatieve intenties van de spreker omvatte, maar ons ook in staat stelde om hun effecten fijnmazig te meten. Hiervoor maakten we gebruik van eerder eyetrackingonderzoek naar het effect van pragmatische inferenties op referentiële resolutie. We presenteren dit experiment in Hoofdstuk 4.

We ontwierpen het eyetrackingexperiment in Hoofdstuk 4 om het effect van sprekerinformativiteit op CSWL te onderzoeken. We vroegen ons af: v) in hoeverre beïnvloedt de sprekerinformativiteit hoe leerders woorden en objecten met elkaar associëren?; en vi) op welk moment ontstaan verschillen in oogfixaties op het doelobject als functie van de sprekerinformativiteit? We pasten het ontwerp uit hoofdstuk 3 aan door uitingen te testen die een zelfstandig naamwoord bevatten gemodificeerd door een bijvoeglijk naamwoord, zoals *De gele banaan*. Als een bijvoeglijke naamwoord vóór het zelfstandig naamwoord staat, trekt de luisteraar meestal de conclusie dat er een contrastieve lezing noodzakelijk is die pragmatisch van aard zou zijn: *de gele banaan* impliceert ook het bestaan van een anderskleurige banaan. Een luisteraar kan een contrastieve gevolgtrekking echter opschorten in de aanwezigheid van, bijvoorbeeld, een over-informatieve spreker, die het bijvoeglijk naamwoord op een overbodige manier gebruikt (bijvoorbeeld door het uitspreken van *De gele banaan* in een context waar slechts één object met die beschrijving zou kunnen corresponderen). Dit kan op zijn beurt invloed hebben op de referent waaraan een leerder een nieuw woord koppelt. We gebruikten een 2 x 2 mixed factorial design, waardoor we de manipulatie van de sprekerinformativiteit zowel binnen als tussen proefpersonen konden testen. We veronderstelden dat leren van een niet-optimaal informatieve spreker (d.w.z. een spreker die de kleureigenschap te informerend gebruikte) ertoe zou leiden dat deelnemers een object zouden kiezen dat qua kleureigenschap concurreerde met het doelobject. Het leren van een optimaal informatieve spreker zou er daarentegen toe leiden dat deelnemers het doelobject verkiezen.

We analyseerden zowel de selectie van het doelobject als de oogbewegingen van de deelnemers naar het doelobject. De resultaten van de objectselectiedata lieten zien dat deelnemers minder geneigd waren om het doelobject te kiezen in een conditie waarin de ene spreker optimaal informatief was en de andere niet, vergeleken met een conditie waarin beide sprekers optimaal informatief waren. Deelnemers in de eerste conditie verschilden echter niet in hun keuze van het doelobject als functie van de sprekerinformativiteit. Om na te gaan of er een sprekergerelateerd effect was, analyseerden we de eyetrackinggegevens van de deelnemers. De resultaten wezen op een vroeg effect van de sprekerinformativiteit, dat optrad voordat de deelnemers de linguïstische stimuli hoorden. Dit effect suggereert dat de sprekerinformativiteit de initiële selectie van objecten als potentiële doelen beïnvloedt. Hoewel dit effect kort is, ondersteunt het de pragmatische aard van contrastieve inferenties met betrekking tot prenominale adjectieven en benadrukt het hoe belangrijk het is om het woordleerproces te meten terwijl het zich in de tijd ontvouwt.

Tot slot geeft Hoofdstuk 5 een overzicht en bespreking van de belangrijkste bevindingen. In antwoord op onze twee algemene onderzoeksvragen trekken we twee belangrijke conclusies: ten eerste dat sociaal-pragmatische informatie een effect kan hebben op de manier waarop volwassen leerders een nieuw woord aan een object koppelen, gegeven een leersituatie die de communicatieve intenties van de spreker benadrukt; en ten tweede dat dit effect vroeg in het leerproces kan optreden, wat alleen kan worden waargenomen met behulp van gevoelige, fijnkorrelige methoden, zoals eyetracking.

About the author

Natalia Rivera-Vera was born on October 24, 1983 in Puerto Montt, Chile. In 2003, she moved to Santiago after finishing high-school. Along the way Natalia discovered linguistics. In 2004, she enrolled in the BA program Linguistics and Spanish Literature at the Pontificia Universidad Católica de Chile (PUC). During her BA she also worked as research and student assistant on several projects and courses, respectively.

After her BA, Natalia taught academic writing skills at the PUC, while working on her application for a Chilean scholarship that allowed her to study abroad. During 2011, she worked as a research assistant in the Laboratory of Experimental Psychology and Neuroscience of the Psychology School of the PUC, under the supervision of dr. Edmundo Kronmüller.

In 2012, Natalia enrolled in the Research Master Brain and Cognitive Science of the Universiteit van Amsterdam (UvA). She did research on second language learning and native language processing under the supervision of prof. dr. Sible Andringa. In 2016, Natalia earned another scholarship granted by the Chilean government to start a PhD project at the UvA. In 2018, and due to unforseeable circumstances, this project had to be discontinued. Nevertheless, on that same year, Natalia started a new PhD project, supervised by prof. dr. Sible Andringa, dr. Edmundo Kronmüller, prof. dr. Padraic Monaghan, and prof. dr. Judith Rispens. She presented her work both in the Netherlands and abroad in several conferences. In 2020, Natalia went on maternity leave.

Between 2021 and 2023, Natalia taught at Leiden University in the BA Latin American studies, and supervised theses in the BA International Studies. In December 2023 Natalia started a post-doc position at Utrecht Univer-

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