

# Experiments in a Dollhouse

When laboratory researchers rummage through the toy box, it can absolutely be of service to the world of basic research. Some 30 years ago, researchers at the Max Planck Institute for Psycholinguistics in Nijmegen decided they wanted a dollhouse – for research purposes, of course. “That research formed the basis for later psycholinguistic research, and is still valid today,” notes Dutch psycholinguist Willem Levelt who, together with Co-Director Wolfgang Klein, a specialist in German studies, established the new Institute for Psycholinguistics in 1980. His experiments with the dollhouse opened up new avenues in what was then still the rather new enterprise of experimental linguistics.

What mental processes take place when we formulate and comprehend spoken utterances? How do children acquire their first language and adults their second or third? How do thought and language influence each other, and what role does the cultural environment play? These are the types of questions that psycholinguists are investigating today. They essentially want to discover the basics of the human language faculty – how language is anchored and processed in the brain. For 27 years now, the Max Planck Institute for Psycholinguistics has been delivering important insights into this and other questions.

When the institute began its work in Nijmegen in 1980, this branch of language research was still in its infancy. Thus, when Willem Levelt and his colleagues unpacked their dollhouse in those first few years, they were conducting truly groundbreaking research. Apart from one American study, they were the first to show interest in a phenomenon that became known to linguists as the “speaker’s linearization problem.” The Max Planck researchers wanted to discover how a speaker deals linguistically with the three-dimensionality of a room, including the things in it, since describing such a room is not as easy as it first appears. This is due to the linear structure of language: “We are unable to utter two words or sentences at the same time,” explains Levelt. It is al-

ready hard for speakers to describe events that follow each other in time. They must decide on an order that will convey their message in such a way that it makes sense, because after all, the idea is that the message be comprehensible to the listener. Too many details or an ill-chosen order are confusing. In simple cases, the order of events to be related dictates the linguistic order of mention, as in the sentence “I opened the door and went out of the house.” However, describing things that have no intrinsic linear structure, such as places, apartments or rooms, is more difficult.

How do humans deal with this problem? In their quest to answer this question, Willem Levelt and his colleagues came up with the idea of procuring a dollhouse for their laboratory. The toy house spans three dimensions; how would these get mapped onto a one-dimensional linguistic order? Experiments using the dollhouse could also be controlled precisely. This unconventional experiment really did prove worthwhile since, as it turned out, those who took part in the experiment made very similar linguistic choices when describing the house. “Most of them went on a tour through the house,” remembers Levelt. “Just like in real life, they started at the front door and described the rooms they saw, like a visitor in a real house. They took the tour in small steps, mentioning relevant objects and features as they went along.”



The psycholinguists' experiments with the dollhouse showed how it's not that easy to find the right words to clearly describe what a room looks like.

Photo: MPS

After this initial success, the psycholinguists refined their methods and developed a new linguistic task: a two-dimensional matrix through which they sent their subjects on imaginary walks. “That also functioned brilliantly,” says Levelt, now Founding Director Emeritus of the institute: “I still use it in presentations today.” He also supplemented the laboratory tests with descriptions of walks the subjects went on outside the institute. “It was as important to us then as it is now to always combine our laboratory work with field work,” stresses Levelt. “So we also sent our subjects into town, into the village or to the zoo.”

These virtual and real research walks provided the Max Planck researchers with new insights into the nature of language and allowed them to develop a theory of linearization based on simple principles – a theory that remains valid today. In those first pioneering years of research, the scientists discovered that speakers combine various strategies to solve the linearization problem. “First, we have maximum connectivity,” says Levelt. “That simply means that things that are spatially linked also follow one another in a description.” For example in the statement: “There is a cupboard in the corner.”

The second problem-solving strategy that Levelt and his colleagues observed was the speakers’ attempts to branch off their route as little as possible. They constructed their descriptions in such a way that to continue them necessitated remembering only the bare minimum of choice nodes – that is, points where they branched off from the main description and to which they thus had to return. The reason behind this strategy was to not cram the memory with too much information. Similarly, the subjects avoided taking the same route twice. “And when they were forced to do so, they would go back only as far as the last choice node,” says Levelt. The speakers thus reassured themselves that they were being thorough in their description. “They could be sure they had not forgotten anything.” Yet the experiments in the initial years proved that this belief is an illusion: “Most of the time, the speakers still forgot things in their descriptions,” explains Levelt.

However, these findings still did not fully uncover the mystery of language production. To find out how the mind/brain works when we want to say something, Levelt and his team devised further experiments, some of which later became key techniques in experimental psycholinguistics.

“We conducted a host of reaction-time experiments,” says the researcher of his other work, which would lead to a new theory of language production, the hierarchical serial model – one of the classic theories in psycholinguistics. In addition to the conceptual stage of speech production that Levelt and his colleagues had identified with the help of the dollhouse and the matrix, by measuring reaction times, he uncovered two further stages. In the experiment, the test per-

## Westfälische Rundschau Hagen news article, November 9, 1980

European scientists carry out basic research. The fundamentals of foreign languages set to become easier to learn (Kleve). It's a linguistic gem that the somewhat remote border town of Kleve in the Lower Rhine region would have loved to have claimed as its own. Yet the new Max Planck Institute for Psycholinguistics, which began life as a working group, has been established just a stone's throw away on the other side of the border in the popular forested area of Berg en Dal near Nijmegen in the Netherlands. (...) Researchers there will investigate how guest workers from all corners of the globe assimilate their new language. The project fits comfortably with the Institute's main task, which is to research the fundamental elements that should ultimately facilitate the acquisition of foreign languages, help overcome speech defects and, ultimately, allow scientists to create “talking” robots.

sons were asked to name the object that appeared on the screen in front of them as quickly as possible. “We measured the time between the picture appearing and the test person starting to speak,” explains Levelt, “and the time lag was usually around three-quarters of a second.”

He was able to observe that there are two stages between seeing the picture and saying the word. First, from its mental lexicon, the brain calls up something that we termed the lemma. It consists of the syntactical features of the target word – for instance, whether it is a noun or a verb. This is

the stage you are in when something is “right on the tip of your tongue.” In lemma selection, the brain chooses the word, for example “dog,” “cat,” or “mouse,” that corresponds to the object, but the word’s sound form isn’t there yet.

That word form appears during the next stage: phonological coding. A string of retrieved word forms is now going to be syllabified; that is the precursor to articulating the syllables of the word. “A different articulatory gesture is required for each syllable in the word,” says Levelt. He and his colleagues have invested much time in researching this language phenomenon, and have discovered a further linguistic secret, the noticeably small vocabulary of syllables. “In 80 percent of our colloquial speech, we utilize no more than 500 different syllables, which we continuously use and re-use. Psycholinguists were not aware of that before.” The results of his research have convinced Levelt that these frequently used syllables are “stored” in the memory as motor-articulatory programs. “We continuously call them up from our memories and execute them by means of our articulatory organs. That was an important discovery,” he notes.

The dollhouse has long since served its purpose, and the psycholinguists in Nijmegen are now working with leading-edge technology: 10 years have already passed since they began to scan the human brain during speech. First they used electroencephalograms to record brainwave activity, then magnetic resonance imaging (MRI and fMRI), and now they are also using magnetic electroencephalography (MEG) at the FC Donders Center. “This equipment allows us to measure the magnetic oscillations of thoughts in milliseconds,” explains Levelt, “a fantastic opportunity for linguistic research.”

Willem Levelt and his colleagues studied the mysteries of language production for almost 30 years at the only Max Planck Institute in the Netherlands, and their discoveries were numerous. “We researched the entire system and produced a blueprint of speaking. Only at the Max Planck Society can you do something like that.” The research in Nijmegen continues – now without Levelt, who is enjoying his well-earned retirement. After all, there is still a whole host of mysteries for the psycholinguists to uncover.

BIRGIT FENZEL