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Producing Simple Sentences: Results from Picture–Word Interference Experiments

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Five experiments investigated the size of the grammatical advance planning unit in the production of simple sentences with transitive and intransitive verbs. The four main experiments used an extension of the picture–word interference task. Native speakers of German described pictures of simple scenes (an actor performing an action or an actor performing an action with an object). The word order of the target utterances was systematically manipulated (verb in utterance initial position or in utterance final position). In addition, speakers were presented with verbs as distractor words which were semantically related or unrelated to the verb of the picture description. For target utterances with intransitive verbs, no effects of the distractor conditions were obtained. For utterances with transitive verbs in initial position, utterance onset latencies were longer for the condition with semantically related distractor verbs than for the condition with unrelated distractor verbs. When the target verb did not occur in utterance initial position, the semantic interference effect was not obtained. These results suggest that the verb is not automatically and obligatorily part of the grammatical advance planning unit for finite clauses.

Speakers produce sentences in an incremental, piecemeal fashion. That is, they do not necessarily plan a complete sentence before they start articulation. Rather, they plan later parts of a sentence while articulating earlier parts (e.g., Kempen & Hoenkamp, 1987; Levelt, 1989; see deSmedt, 1996, for an overview). The incrementality of sentence production guarantees the speed and fluency of speaking.

Incrementality is assumed to apply to all levels of processing involved in speech production. At the first processing level, grammatical encoding, lemmas corresponding to the lexical concepts specified in the preverbal message are retrieved from the mental lexicon and the syntactic structure of the sentence is generated. Lemmas are abstract lexical entities specifying the syntactic properties of words. For example, verb lemmas contain the verb's subcategorization frame and argument structure, specifying which thematic roles in the preverbal message (e.g., AGENT, THEME, etc.) have to be assigned to which grammatical functions (e.g., subject, direct object, etc.). Incrementality at the level of grammatical encoding has at least two aspects. First, not all lemmas occurring in a sentence have to be retrieved before articulation starts. Second, the syntactic structure of a sentence is not necessarily determined completely before articulation starts. At the next processing level, phonological encoding, the phonological forms of the words are retrieved from the mental lexicon, and the phonological form of the sentence is determined. Phonological encoding is assumed to proceed from left to right (e.g., Meyer, 1992; Meyer & Schriefers, 1991). Experimental evidence shows that speakers can initiate articulation before having determined the phonological form of the complete utterance (e.g., Meyer, 1996; Schriefers & Teruel, in press).

Given the assumption of incremental production, one important issue concerns the size of the increments, or advance planning units, at the different processing levels (see Dell & O'Seaghdha, 1992). The present paper addresses the question of the advance planning unit at the level of grammatical encoding in the production of simple sen-

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tences with transitive and intransitive verbs. For the following, the grammatical advance planning unit is defined as the piece or increment of syntactic structure that is completed before processing on the next levels (phonological encoding and articulation) can be initiated. Phonological encoding and articulation can only be initiated if grammatical encoding has reached a point at which those grammatical features have been determined that have a direct reflection in the phonological form of the first word of the utterance. Before turning to the experiments, we will briefly discuss some of the available evidence on the size of planning units in grammatical encoding.

It is generally assumed that the advance planning units at early levels of processing, i.e., grammatical encoding, are larger than at later levels, i.e, phonological encoding (e.g., Bock, 1991). Evidence for this assumption comes from the properties of word and phoneme exchange errors. Word exchange errors typically involve words from the same syntactic class, occurring in different phrases of a clause. Phoneme exchange errors, by contrast, often involve phonemes from words of different syntactic classes which are relatively close to each other in the utterance. The differences between the two types of errors suggest that word exchanges originate at the level of grammatical encoding and phoneme exchanges at the level of phonological encoding (e.g., Garrett 1975, 1976). The difference with respect to the distance across which these exchange errors occur suggests that grammatical encoding operates with larger planning units than phonological encoding.

Experimental evidence concerning the size of planning units comes from a recent study by Meyer (1996; see also Sleiderink, 1996). She presented participants with pairs of objects that had to be described by noun phrase conjunctions (e.g., "the arrow and the bag") or simple sentences (e.g., "the arrow is next to the bag"). In addition, participants were presented auditorily with distractor words. These distractor words were either semantically or phonologically related to the first or second noun of the target utterance. Utterance onset latencies were longer with semantically related distractors than in a control condition with unrelated distractors, and this was the case for the first and the second noun. Distractors that were phonologically related to the first noun reduced utterance onset latencies relative to the control condition with unrelated distractors. No such phonological facilitation effect was obtained for the second noun. Thus, the results of Meyer's (1996) picture–word interference experiments suggest that, for these types of utterances, both noun lemmas, but only the first noun's phonological form, are retrieved before utterance onset.

Kempen and Huijbers (1983), following up on experiments by Lindsley (1975, 1976), investigated the size of grammatical planning units for the production of simple subject–verb and verb–subject sentences in Dutch. The participants in these experiments described pictures of an actor performing an action. They were instructed to name only the actor (e.g., "man"), only the action (e.g., "greet"), or the complete scene by either a subject–verb (e.g., "man greets") or verb–subject (e.g., "greets man") sentence. The latter word order is used in Dutch for main clauses starting with adverbials (e.g., "hier groet de man," "here greets the man"). In the experiments, this word order was induced by presenting participants with a corresponding adverbial (e.g., "hier," "here") and instructing them to describe the pictures such that the description would form a natural and grammatically correct continuation of this sentence beginning. The results showed longer utterance onset times for action-only descriptions than for actor-only descriptions. Furthermore, the latencies for action-only descriptions were about equal to the latencies for subject–verb and verb–subject utterances.

This suggests that speakers do not initiate a subject–verb utterance when they have retrieved the subject noun; rather, initiation of verb–subject *and* subject–verb utterances is delayed until both the noun lemma and the verb lemma have been retrieved. Based on these and additional results, Kempen and Huijbers (1983) proposed that speakers retrieve the verb lemma and the noun lemma in parallel. After both lemmas have been retrieved, phonological encoding starts with the first word of the eventual utterance. This proposal raises the question of whether speakers delay initiation of subject–

verb utterances until successful retrieval of the verb lemma because the verb has some special status in grammatical encoding. The present experiments address this question by asking whether the verb lemma has to be retrieved *obligatorily* before articulation of a sentence can be initiated. In the following, we will sketch different theoretical proposals on this issue.

Two major positions concerning the processes of grammatical encoding can be distinguished, conceptual and lexical guidance (e.g., deSmedt, 1996). Under the assumption of conceptual guidance, the syntactic plan of a sentence can be derived directly from the content and the structure of the preverbal message. Fisher, Gleitman and Gleitman (1991) have shown that there are rather close correspondences between the meanings of verbs and their subcategorization frames. For example, whether a verb is transitive or not is, to a large extent, predictable from the kind of action it expresses. Under the conceptual guidance view, the choice of a syntactic plan for a sentence with, for example, a transitive versus an intransitive verb could be based on the conceptual representation of the to-be-expressed meaning and would not necessarily require selection of the verb lemma which specifies the verb's subcategorization frame and argument structure.

However, some verbs that are highly similar in meaning nevertheless differ in their subcategorization frames and argument structures (e.g., "replace X with Y" and "substitute Y for X"; see deSmedt, 1996). Such examples suggest lexical guidance, i.e., the choice of a verb determines the syntactic structure of an utterance. Lexical guidance of grammatical encoding by the information contained in a verb lemma can be described as the problem of function assignment (Bock & Levelt, 1994). The lexical concepts of the preverbal message fulfil different event roles (e.g., AGENT, PATIENT). The lexical concepts must not only be mapped onto corresponding lemmas, but they must also be assigned to syntactic functions (e.g., subject, direct object). These syntactic functions are usually morphologically marked in case languages, or structurally marked in configurational languages. Although there is often a close correspondence between the event roles of lexical concepts and their corresponding lemmas' syntactic functions in a sentence (e.g., AGENT–subject, PATIENT–direct object), there are also deviations from these correspondences (e.g., the verb "receive" requires the event role RECIPIENT to be assigned to the grammatical function subject and not to the grammatical function of indirect object). Thus, the mapping between event roles and syntactic functions appears to be at least in part determined by the requirements of specific verbs (e.g., Grimshaw, 1990). This suggests that the verb lemma should play a central role in grammatical encoding. In its strongest version, this hypothesis predicts that the verb lemma is always an obligatory part of the grammatical planning unit for a sentence.

The view just sketched not only subscribes to lexical guidance in grammatical encoding, but also gives the verb lemma a privileged role in grammatical encoding. Bock and Levelt (1994) expressed this position clearly: "A verb's specification of its normally expressed arguments may serve to organize function assignment around a unit that is roughly equivalent to a clause" (p. 966). This set of processes "yields an activated set of lemmas and a set of syntactic functions, linked together via the argument structures of the lemmas (notably the verb)" (Bock & Levelt, 1994, p. 968).

The results of Kempen and Huijbers are compatible with such a special status for the verb in grammatical encoding. However, other evidence suggests that grammatical encoding is also strongly influenced by the semantic–conceptual properties of the participants in a to-be-described event. For example, animate and concrete entities have a strong tendency to occupy the grammatical function of subject (e.g., Bock, Lobell, & Morey, 1992; Bock & Warren, 1985; McDonald, Bock, & Kelly, 1993). Some models of grammatical encoding further assume that the order in which lemmas become available has a direct influence on grammatical encoding (see Bock, 1982, for arguments that more accessible words tend to appear earlier in sentences). The incremental sentence formulator of deSmedt (1990, 1996), for example, assumes that the first available noun lemma tends to

occupy the subject position of a sentence. As deSmedt (1996) points out, this can occasionally lead to situations in which the speaker talks herself or himself into a corner. For instance, it is impossible to continue a German sentence beginning with "der Film" (the film, nominative case) to express the fact that a particular person has wanted to see the film (deSmedt, 1996).

Related phenomena might also play a role in cases like the following German utterance:

Der Mann, den habe ich im Zug gesehen
The man (nom.), the (acc.) have I in the train seen

Although this utterance sounds perfectly natural in German, it may actually contain a repair. First, the speaker produces a singular noun phrase in nominative case. Following the arguments of deSmedt (1996), the corresponding noun lemma might have become available first and was by default assigned to the subject function (nominative). After uttering this first noun phrase, it becomes clear that the noun phrase should serve as the direct object of the sentence. The speaker solves this problem by producing a definite determiner of the matching gender in accusative case ("den," which has the function of a pronoun in this situation) and then continues the utterance. One can also argue that such utterances are used to focus on the first noun phrase. However, this appears unlikely as the adequate focused sentence should be "Den Mann (acc.), den (acc.) habe ich im Zug gesehen."

In summary, theoretical as well as empirical evidence appears to support the claim that the verb lemma plays a central role in grammatical encoding. In its strongest version, this would imply that the verb lemma is always and obligatorily part of the grammatical advance planning unit for a clause or sentence. However, there is also evidence that other factors, such as the conceptual–semantic properties of the participants in an event and the temporal order in which lemmas become available, exert an influence on grammatical encoding. This suggests that, at least under certain circumstances, the verb lemma is not necessarily part of the grammatical planning unit for a clause or sentence.

The experiments reported in the present paper investigated these two hypotheses, focusing on whether the verb is an obligatory part of the grammatical advance planning unit. In all experiments, native speakers of German described pictures of simple events consisting of an actor performing some action (e.g., a girl who laughs, requiring the use of an intransitive verb) or an actor performing some action with an object (e.g., a man who opens a door, requiring the use of a transitive verb). Word order was varied in a way similar to the study by Kempen and Huijbers (1983). Before the to-be-described picture was presented, speakers heard sentence beginnings (hereafter called lead-in fragments), which they had to complete by a picture description in such a way that the lead-in and the picture description resulted in a grammatical utterance. Two types of lead-in fragments were used. The first one ("auf dem nächsten Bild sieht man wie . . . ," "on the next picture one sees how") requires a description of the form subject–verb (for intransitive verbs) or subject–object–verb (for transitive verbs). The other lead-in ("und auf dem nächsten Bild . . . ," "and on the next picture") requires a description in the format verb–subject (for intransitive verbs) or verb–subject–object (for transitive verbs).

This variation of word order has its background in the following principles of German syntax (see Duden, 1972, Vol. 9). The word order in German main clauses is subject–verb or subject–verb–object. In subordinate clauses, however, the verb must occur in clause final position, yielding the order subject–verb or subject–object–verb. In sentences beginning with an adverbial or a so-called conjunctional adverbial (e.g., "gestern"–yesterday, "daher"–hence) or a prepositional phrase (e.g., "in diesem Artikel behauptet der Autor . . ."–"in this paper claims the author . . ."), the verb has to precede subject and object (verb–subject, or verb–subject–object; this latter word-order principle is also referred to as inversion; Duden, 1972, Vol. 9).

The experimental induction of word-order variation (verb-first versus verb-last) was combined with the presentation of distractors. The distractors were also verbs. In two of the distractor conditions, the distractors were either semantically related to the verb in the picture

description (e.g., target verb: "laugh," distractor: "cry") or unrelated (target verb: "laugh," distractor: "swim"). For the simple naming of depicted actions, Roelofs (1993) has shown that semantically related distractor verbs prolong naming latencies relative to a condition with unrelated distractors. This effect will be called the semantic interference effect.

The critical question is whether a semantic interference effect obtains irrespective of the position of the verb (utterance-initial versus utterance-final position) or whether it only obtains for utterance-initial verb position. If the verb is part of the grammatical advance planning unit of the to-be-produced utterance (i.e., if function assignment can only be carried out on the basis of the verb lemma), then the semantic interference should be obtained independent of verb position. If the verb is not part of the advance planning unit, then no semantic interference should be found for utterances with the verb in final position.

In an additional distractor condition, we tried to introduce an interference effect with the target verb's subcategorization frame. If the target verb was a transitive verb, the distractor was an intransitive verb, and vice versa. This distractor condition will hereafter be referred to as the syntactic interference condition, or SYN condition. If the verb's subcategorization frame and argument structure play a central role in grammatical encoding, then we would expect the SYN condition to lead to interference relative to the unrelated condition in which target verb and unrelated distractor did not differ in their syntactic specifications. The reasoning behind this prediction is as follows. If grammatical encoding is lexically guided and if the verb lemma's subcategorization information plays a central role in grammatical encoding, an intransitive distractor verb should set up a syntactic frame for a sentence without a direct object, whereas the target verb requires a syntactic frame for a sentence with a direct object. This competition between the subcategorization frames of the target and the distractor verb should prolong selection of the target verb's subcategorization frame (for related evidence concerning such a competition for the selection of grammatical gender, see LaHeij, Mak, Sander, & Willebordse, in press; Schriefers, 1993; van Berkum, 1997).

Before moving to the experiments, one additional issue must be mentioned. The model of Kempen and Huijbers (1983) assumes that the noun lemma and the verb lemma for subject–verb or verb–subject utterances are retrieved in parallel. Let us assume that, for the materials of our experiments, retrieval of the verb lemma was considerably faster than retrieval of the noun lemma. In this situation, a slowing of verb lemma retrieval by semantically related distractors could still result in verb lemma retrieval's being faster than noun lemma retrieval. In this case, semantic interference with verb lemma retrieval would not be reflected in utterance onset latencies. Experiment 1 was designed to provide rough estimates of the retrieval speed for verb lemmas and noun lemmas of our materials. In addition, it was designed to determine whether speakers can easily produce utterances matching the different lead-in fragments.

EXPERIMENT 1

Experiment 1 established whether naming the action (hereafter V-naming) was slower than naming the actor (hereafter S-naming) for the set of pictures used throughout the present experiments. In addition to naming the depicted action or actor, the participants also received a block of experimental trials in which they heard the lead-in fragments (see above) and described the pictures such that the descriptions formed a natural continuation of the lead-in.

The latter block of trials served two purposes. First, it provided data on the ease with which speakers can produce picture descriptions as continuations of the lead-in. Second, half of the participants of Experiment 1 also participated in Experiment 2; the other half of the participants also participated in Experiment 3. Thus, Experiment 1 familiarized participants with the to-be-described pictures and the description task with lead-in fragments.

Participants

Thirty-two native speakers of German, most of them students at the Free University Berlin,

participated. They were either paid for participation or received course credit.

Materials

Twenty-four different pictures were used. Half of these pictures depicted an actor performing some action, requiring picture descriptions consisting of a subject noun phrase (in nominative case) and an intransitive verb (e.g., "laugh," "cry" etc.).[1] The other twelve pictures depicted a scene with an actor performing some action with an object, requiring descriptions consisting of a subject noun phrase (in nominative case), a transitive verb (e.g., "open," "close"), and a direct object noun phrase (in accusative case).

For each of the two sets of 12 pictures, the target verbs were organized into 6 pairs, the verbs within each pair being cohyponyms in a contrastive relation (e.g., cry–laugh, close–open etc.). For simple action naming, Roelofs (1993) has shown that naming an action (e.g., "cry") in the presence of its cohyponym as distractor (e.g., "laugh") leads to longer naming latencies than in the presence of an unrelated verb as distractor (e.g., "jump"). For the two pictures of each pair, the two different actions were performed by the same actor (e.g., a girl crying versus a girl laughing; see Appendix 1 for a list of the verbs and Appendix 2 for example pictures).

In Experiments 2 through 5, the verbs of each pair were used as target and semantically related distractor (e.g., target: cry, distractor: laugh, and target: laugh, distractor: cry). To obtain a semantic interference effect for verbs, the verbs within each pair should be close semantic competitors. In order to operationalize this semantic competitor relation, we conducted a pilot experiment applying the so-called "negation test" (Miller, 1969) to our pairs of verbs. In this pilot experiment, sixteen participants (different from those participating in Experiments 1 through 5) were presented with a sentence fragment like "the girl does not laugh, but . . ." and the corresponding picture depicting the (negated) action.[2] Participants were instructed to complete the sentence fragment, with half of the participants being presented one verb of each pair (and the corresponding picture, e.g., laugh), and the other half being presented the other verb of each pair (e.g., cry). In this situation, speakers tend to complete the sentence with a verb which preserves most of the meaning of the verb given in the sentence fragment (e.g., Levelt, 1989, p. 213). For all twelve pairs of verbs used in the present experiments, at least 12 of the 16 participants completed the sentences with the other verb of the pair. The results of this pilot experiment also provided a constraint for the selection of the distractor verbs for the unrelated condition in Experiments 2 through 5. The unrelated distractor for each target verb was selected such that the distractor verb had not been produced as a completion to the respective target verb, thus maximizing semantic distance between target verbs and unrelated distractors.

Procedure

Participants were seated in a dimly lit room at a distance of about .6 m from a computer screen on which the pictures were presented. The experiment consisted of three blocks. In the actor-naming block, participants were shown the 24 pictures one by one, with the instruction to name the actor as quickly as possible (without a determiner). In the action-naming block, participants were instructed to name the action depicted on the pictures, using the infinitive form of the respective verbs. In the sentential-description block, participants were instructed to name the pictures such that their description would form a natural continuation of the preceding lead-in fragment. Each of the 24 pictures was presented once with the lead-in fragment inducing verb-initial descriptions (expected response formats: V–S or V–S–O), and

[1] During selection of materials, it became clear that it is impossible to select purely intransitive verbs describing easily depictable actions. Most of the selected intransitive verbs allow for a direct object in some specialized (quasi-idiomatic or frozen) combinations (e.g., "laugh"–"he laughs a happy laughter"). Nevertheless, according to a dictionary of German verbs (Helbig & Schenkel, 1973), the selected verbs can be considered as basically intransitive verbs.

[2] The pictures were presented together with the sentence fragments because we expected that the actual way of depicting an action might have some influence on what would be considered a semantic competitor.

once with the lead-in fragment inducing verb-final descriptions (expected response formats: S–V or S–O–V).

Half of the participants received first the actor-naming block, followed by the action-naming block and the sentential-description block. The other half of the participants received first the action-naming block, followed by the actor-naming block and the sentential-description block.

The experimental trials of the actor-naming block and the action-naming block were randomized under the following restrictions: (i) two identical actors were not allowed to occur on two successive trials; (ii) two actions from a given pair of actions were not allowed to occur on two successive trials. For the block with sentential descriptions, the following additional restrictions were used: (iii) the two repetitions of the same picture (with different lead-ins) were not allowed to occur on successive trials; (iv) the same lead-in fragment was not allowed to occur on more than three successive trials. A different randomization was determined for each of the three blocks.

In the actor-naming and the action-naming blocks, the picture was presented for 700 ms. With presentation of the picture, reaction time measurement was started. Reaction times were measured until a voice key was triggered by the beginning of the participant's naming response. Two thousand ms after offset of the picture, the next trial started with the presentation of the next picture. For the sentential-naming block, the lead-in was first presented via headphones. One thousand ms after the end of the lead-in, a picture appeared on the screen for 700 ms. Reaction time was measured from the beginning of picture presentation to the beginning of the participant's description. Three thousand ms after offset of the picture, the next trial started with the auditory presentation of the lead-in.

Before the experiment started, participants were familiarized with the pictures by studying a booklet containing the 24 pictures. Beside each picture, the words to be used in the picture descriptions were printed. Participants were instructed to use only these words for their naming responses.

TABLE 1

Mean Utterance Onset Latencies as a Function of Verb Type (Intransitive versus Transitive Verbs) and Type of Naming (S, V, S-(O)-V, V-S-(O)) in Experiment 1

	Utterance type			
Verb type	S	V	S-(O)-V	V-S-(O)
Intransitive	763	939	834	936
	(6.5)	(13.0)	(13.0)	(14.3)
	[48]	[71]	[50]	[70]
Transitive	725	921	801	854
	(6.5)	(13.0)	(9.1)	(9.4)
	[75]	[70]	[70]	[105]

Note. Percentage of erroneous responses in parentheses; standard deviations in square brackets.

Results and Discussion

All trials with erroneous responses were excluded from further analysis of utterance onset latencies, as were trials with naming latencies longer than 2000 ms. This led to the exclusion of 11.6% of all data points. Utterances were classified as errors if (a) they contained words different from the ones presented during the familiarization with the pictures, (b) they started with a filled pause (e.g., uhm), (c) they contained a filled or unfilled pause between the words of the utterance, or (d) they started with a nonspeech sound triggering the voice key. In addition, for sentential descriptions, utterances were excluded in which the produced word order did not conform with the lead-in fragment. For the remaining data points, all reaction times deviating more than two standard deviations from a subject's and an item's mean in a given condition were substituted by estimates using the procedure recommended by Winer (1971). This was the case for 1% of all data points.

The results are given in Table 1 as a function of verb type (intransitive versus transitive) and utterance type. The naming latencies were analyzed in subject and item analyses of variance with the factors of verb type (transitive versus intransitive verbs) and utterance type (S, V, S–(O)–V, V–S–(O)). In the item analysis, pictures were treated as nested under verb type.

The main effect of utterance type was significant by subjects and by items ($F1(3,90) = 42.1$, $p < .005$, $MS_e = 10422$; $F2(3,66) = 27.7$, $p < .005$, $MS_e = 5929$). The main effect of verb type was significant by subjects ($F1(1,30) = 31.9$, $p < .005$, $MS_e = 3719$; $F2(1,22) = 2.6$, $P = .10$, $MS_e = 17290$) as was the interaction of the two factors ($F1(3,90) = 5.1$, $p < .01$, $MS_e = 2467$, $F2(3,66) < 1$). Post hoc tests (Duncan, $p < .05$) revealed that for utterances with intransitive verbs all pairwise differences between the four utterance types were significant, except the difference between V- and VS-utterances. For the picture set with transitive verbs, all pairwise differences between the four utterance types were significant.

Erroneous responses were determined by listening carefully to the tape recordings of the experimental sessions. Analyses of errors showed that for both picture sets with transitive and intransitive verbs, S-utterances had a significantly smaller number of errors than did the remaining three utterance types, which did not differ significantly from each other. The difference between S- and V-utterances was primarily due to V-utterances starting with a filled pause (4% across the intransitive and the transitive set), and a higher number of responses other than the designated responses for V-utterances than for S-utterances (7 and 4%, respectively, across the intransitive and the transitive set). The number of nontarget verb usage dropped again for the two types of sentential descriptions produced in the third experimental block (4% across the transitive and the intransitive set). Approximately 3% of the errors in sentential descriptions were due to word orders not conforming to the lead-in, indicating that participants were fairly good in producing utterances conforming to the lead-in. Finally, both types of sentential descriptions (verb-first and verb-last) yielded approximately equal percentages of utterances with within-utterance hesitations and pauses (2.8 and 3.2 %, respectively).

The results show that actor-naming latencies (S) are shorter than action-naming latencies (V). Furthermore, the participants had no problem producing sentential descriptions that completed the lead-in fragments in a grammatically correct way. The number of word order errors in the sentential descriptions was low (3% on average). This was the case despite the rather vague instruction to "describe the pictures such that the description forms a natural continuation of the preceding sentence beginning."

In contrast to the results of Kempen and Huijbers (1983, Experiment 1), utterance onset latencies for action-only (V-utterances) naming tended to be longer than the corresponding latencies for the sentential descriptions. This is particularly obvious for utterances with transitive verbs. At least with the procedure used in the present experiment (blocking of S- and V-utterances, followed by a mixed block of S–(O–)V and V–S–(O) utterances), a direct comparison of single-word naming latencies and sentence onset latencies is problematic. In particular, it is unclear how the finding of longer latencies for V-utterances than for verb-initial sentences (V–S, V–S–O) can be reconciled with the assumption that latencies for single word utterances can be used as predictors for onset latencies for multiword utterances, as suggested by Kempen and Huijbers. We will therefore approach the question of whether the verb is an obligatory part of the grammatical advance planning unit for sentential utterances from a different perspective, one which does not rely on the comparison of onset latencies for single word utterances and sentences.

EXPERIMENT 2

In this experiment, participants produced sentential descriptions of the pictures used in Experiment 1. Two different formats of the descriptions, verb-initial and verb-final, were induced by the same lead-in fragments used for the sentential descriptions in Experiment 1. In addition, participants were presented with distractor words. The critical question is whether effects of the distractor conditions occur independent of the verb position or whether they only occur when the verb is in initial position. Thus, the basic logic of the experiment is the same as in the study of Meyer (1996), who also asked whether a lemma not occurring in utterance-initial position was retrieved before utterance onset.

Participants

Sixteen of the 32 participants of Experiment 1 participated in the experiment immediately after having participated in Experiment 1.

Materials

The same 24 pictures as in Experiment 1 were used. The same two lead-in fragments were used as in Experiment 1. Each picture was presented five times with the lead-in inducing utterance-initial verb position and five times with the lead-in inducing utterance-final verb position. On the five repetitions of a given picture with a given lead-in, five different distractor conditions were realized.

In the first distractor condition, the distractor was semantically related to the target verb (hereafter SEM; e.g., target verb: "cry"; distractor: "laugh"). In the SEM condition, target and distractor always came from the same pair of verbs (see Appendix 1; for the operationalization of semantic relatedness, see Experiment 1, *Materials*). In the second distractor condition, the distractor verb was semantically unrelated to the target verb (hereafter UNR). For a target verb from a given pair of cohyponyms, the distractor verb for the UNR condition was one of the verbs from the remaining five verb pairs (under the restriction described in the materials section of Experiment 1). Note that in the SEM and UNR conditions, target verb and distractor verb always have the same subcategorization frame. In the third distractor condition, the distractor verb was semantically unrelated to the target verb, but had a different subcategorization frame. Therefore, the distractor verb for a given target verb was selected from the other set of verbs with a different subcategorization frame. This distractor condition will hereafter be referred to as the syntactic (SYN) condition. In the fourth distractor condition, the distractor verb was identical with the target verb (e.g., target verb: "cry", distractor: "cry", hereafter referred to as IDENTICAL). Finally, in the fifth condition, the pictures were not paired with any distractor (hereafter NONE). The distractor verbs were always presented in their third person singular form. There were 240 trials (2 (lead-in) $\times$ 2 (verb sets: transitive versus intransitive) $\times$ 12 (verbs per set) $\times$ 5 (distractor conditions)). To keep the experimental sessions at an adequate length and to prevent speakers from producing utterances with different wording than the target utterances, no additional filler trials were included.

The 240 trials were randomized such that (i) the same picture did not occur in direct succession; (ii) the distractor verb of a given trial was not the target verb on the next trial; (iii) the same distractor condition occurred maximally three times in direct succession; (iv) the same lead-in occurred maximally three times in direct succession; (v) pictures of the transitive set or the intransitive set occurred maximally three times in direct succession. Two randomizations were constructed according to these restrictions, with half of the participants being assigned to each randomization.

Procedure

Participants were tested individually. They were seated in a dimly lit room at a distance of about .6 m from a computer screen on which the pictures were presented. Lead-in fragments were presented via headphones as were the distractor verbs. In addition, the distractor verbs were also presented in written form, to the left and to the right of the picture which was always centered in the middle of the screen. Although this double presentation of distractors (visual and auditory) differs from the procedure used in related research (e.g., only auditory distractor presentation, as in Meyer, 1996), we used a double presentation mode because we did not have any advance knowledge about the size of potential effects of distractors on verb lemma retrieval in this experimental situation. Therefore, we wanted to make sure that the participants could not suppress the distractors.

On each trial, the lead-in fragment was first presented via headphones. One thousand ms after the end of the lead-in, the picture, flanked to the left and right by the distractor verb, appeared on the screen. At the same moment, the distractor verb was also presented auditorily via headphones. Thus, the stimulus onset asynchrony (SOA) for both visual and auditory distractors was 0 ms. The picture and the visually presented distractors remained on the screen for 700 ms. Three

TABLE 2

Mean Utterance Onset Latencies for Description with Transitive Verbs and Intransitive Verbs as a Function of Word Order and Distractor Condition in Experiment 2

		Distractor condition				
Verb type	Word order	SEM	UNR	SYN	IDENT	NONE
Intransitive	S-V	815	837	829	823	738
		(4.7)	(3.6)	(8.3)	(3.6)	(4.2)
		[148]	[165]	[146]	[162]	[127]
	V-S	897	899	884	885	783
		(3.1)	(5.7)	(6.2)	(5.7)	(6.2)
		[107]	[111]	[122]	[140]	[108]
Transitive	S-O-V	870	880	883	859	766
		(6.8)	(7.8)	(6.2)	(4.7)	(4.2)
		[175]	[171]	[170]	[181]	[146]
	V-S-O	994	920	937	886	829
		(7.3)	(9.4)	(5.2)	(8.3)	(7.3)
		[94]	[107]	[113]	[112]	[97]

Note. Percentage of erroneous responses in parentheses; standard deviations in square brackets.

thousand ms after offset of the picture, the next trial started with the auditory presentation of the lead-in. Reaction times were measured from the beginning of the picture presentation to the beginning of the participants' sentential description by means of a voice key.

Results

Exclusion of trials from further analysis (5.9%) followed the same principles as in Experiment 1. For the remaining data points, extreme reaction times were substituted by estimates following the procedure used in Experiment 1. This was the case for 0.5% of all data points. Table 2 gives the mean utterance onset latencies as a function of verb type (intransitive versus transitive), word order (verb-final versus verb-initial), and distractor condition.

Analyses of variance of utterance onset latencies with the factors of verb type (intransitive versus transitive verbs), word order (verb last versus verb first), and distractor condition revealed significant main effects of all three factors (verb type: $F1(1,15) = 20.9$, $p < .005$, $MS_e = 7232$, $F2(1,22) = 3.9$, $p < .05$, $MS_e = 29717$; word order: $F1(1,15) = 8.9$, $p < .01$, $MS_e = 33884$, $F2(1,22) = 23.6$, $p < .005$, $MS_e = 9580$; distractor condition: $F1(4,60) = 28.7$, $p < .005$, $MS_e = 4923$, $F2(4,88) = 53.8$, $p < .005$, $MS_e = 1986$). In addition, the interaction of distractor condition and word order ($F1(4,60) = 3.9$, $p < .01$, $MS_e = 2249$, $F2(4,88) = 4.4$, $p < .01$, $MS_e = 1597$) and of verb type and distractor condition ($F1(4,60) = 4.4$, $p < .01$, $MS_e = 1781$, $F2(4,88) = 3.0$, $p < .05$, $MS_e = 1968$) were significant. Finally, the triple interaction between the three factors was significant in the subject analysis ($F1(4,60) = 2.6$, $p < .05$, $MS_e = 1559$, $F2(4,88) = 1.8$, $p = .13$, $MS_e = 1579$).

The results of the overall analyses indicate that the pattern of reaction times in the distractor conditions varies as a function of word order and verb type. This is supported by separate analyses of variance for the picture set with intransitive verbs and the picture set with transitive verbs, with the factors of word order and distractor condition. For the picture set with intransitive verbs, both main effects were significant (word order: $F1(1,15) = 9.1$, $p < .01$, $MS_e = 16409$, $F2(1,11) = 10.2$, $p < .01$, $MS_e = 11009$; distractor condition: $F1(4,60) = 18.9$, $p < .005$, $MS_e = 3286$, $F2(4,44) = 26.6$, $p < .005$, $MS_e = 1752$). The interaction between the two factors was not significant ($F1(4,60) < 1$, $F2(4,44) < 1$). By contrast, for the picture set

with transitive verbs, both main effects and their interaction reached significance (word order: $F1(1,15) = 7.6$, $p < .05$, $MS_e = 19972$, $F2(1,11) = 14.0$, $p < .005$, $MS_e = 8151$; distractor condition: $F1(4,60) = 25.4$, $p < .005$, $MS_e = 3419$, $F2(4,44) = 29.8$, $p < .005$, $MS_e = 2183$; interaction: $F1(4,60) = 6.1$, $p < .01$, $MS_e = 1843$, $F2(4,44) = 8.1$, $p < .005$, $MS_e = 1044$). In order to explore this pattern further, we performed Duncan tests (by subjects and by items, $p < .05$) for each of the four combinations of verb type and word order separately. For utterances with intransitive verbs in sentence final position (subject–verb), the Duncan tests showed that the NONE condition had shorter utterance onset latencies than the remaining four conditions, which did not differ significantly from each other. The same pattern of results obtained for utterances with intransitive verbs in sentence initial position (verb–subject) and for utterances with transitive verbs in sentence-final position (subject–object–verb). For verb-initial utterances with transitive verbs (verb–subject–object), however, the Duncan tests showed that all pairwise comparisons were significant, except for the difference between the UNR and the SYN condition. In particular, we obtained a significant semantic interference effect (the 74 ms difference between SEM and UNR). Although the difference between the UNR and the SYN conditions was in the expected direction, it did not reach significance.

Analyses of erroneous responses did not reveal any significant effects. Note that the overall percentage of errors was lower in the present experiment than for the corresponding sentential descriptions in Experiment 1. This presumably occurred because the participants had participated in Experiment 1 and were therefore more familiar with the critical pictures and their descriptions than during Experiment 1. Errors due to within-utterance hesitations and pauses were about equally frequent in verb-last and verb-first utterances (across the two verb sets and the five distractor conditions 2.2 and 2.4%, respectively). This finding indicates that, in the case of verb-last utterances, speakers did not simply blurt out the subject noun phrase, at the risk of having to interrupt the utterance in order to plan the remainder of the utterance. Rather, the majority of verb-first and verb-last utterances were uninterrupted fluent utterances.

Discussion

The results for utterances with intransitive verbs do not show any systematic effects of the distractor conditions. One might suspect that we did not obtain a semantic interference effect (SEM versus UNR) because the semantic relation between target verbs and distractor verbs in the SEM condition was not strong enough. However, this appears to be unlikely. Roelofs (1993) found significant semantic interference effects with combinations of target and distractor verbs having the same semantic relation as in the present experiment. Furthermore, half of the intransitive verb pairs were the German equivalents of Dutch pairs for which Roelofs (1993) obtained a semantic interference effect. Moreover, the pilot experiment mentioned above (Experiment 1, *Materials*) showed that semantic relatedness in the intransitive and the transitive verb sets was equally strong. It is also possible that the present extension of the picture word interference paradigm is, in principle, insensitive to any systematic variation of the relation between target verb and distractor verb. However, the results for the utterances with transitive verbs show systematic effects, excluding this second option. Therefore, we conclude that there must be something particular about utterances with intransitive verbs that blocks corresponding effects. We will return to this issue in the discussion of Experiment 3.

The results for utterances with transitive verbs in utterance-initial position show a significant semantic interference effect as well as a significant facilitation effect from identical distractors. No comparable effects were obtained when the verb occurred in final position. This result supports the hypothesis that the verb is not an obligatory part of the grammatical advance planning unit for sentences consisting of a verb, a subject, and a direct object. That is, the production system does not necessarily have to wait for successful retrieval of the verb lemma when it occurs late in the utterance. Put differ-

TABLE 3

Mean Utterance Onset Latencies for Descriptions with Transitive Verbs and Intransitive Verbs as a Function of Word Order and Distractor Condition in Experiment 3

		Distractor condition				
Verb type	Word order	SEM	UNR	SYN	IDENT	NONE
Intransitive	S-V	834	841	823	809	914
		(8.3)	(3.1)	(5.2)	(3.6)	(3.6)
		[219]	[205]	[203]	[190]	[124]
	V-S	942	929	903	893	966
		(4.2)	(4.2)	(3.6)	(2.6)	(3.1)
		[134]	[163]	[137]	[210]	[104]
Transitive	S-O-V	860	871	892	848	935
		(6.8)	(8.3)	(8.9)	(5.7)	(4.7)
		[216]	[198]	[199]	[187]	[122]
	V-S-O	1021	943	1004	879	1000
		(12.7)	(6.8)	(6.8)	(4.2)	(5.2)
		[162]	[148]	[166]	[204]	[115]

Note. Percentage of erroneous responses in parentheses; standard deviations in square brackets.

ently, the language production system does not automatically and obligatorily use syntactic information associated with the verb lemma as the basis of grammatical function assignment.

However, this conclusion is based on the contrast between the significant results for utterances with transitive verbs in initial position and the null results for the other three utterance types. In order to have a safer basis for this conclusion than just one significant result, the next two experiments aimed at replicating and extending this pattern of results. The next experiment was a replication of Experiment 2 with an SOA of +200 ms (i.e., the distractor was presented 200 ms after picture onset). If the retrieval of the verb lemma precedes the retrieval of its associated syntactic information, it could be the case that an effect of the SYN condition can only be picked up at such a later SOA.

EXPERIMENT 3

Participants

Sixteen of the 32 participants of Experiment 1 participated in the experiment right after Experiment 1. No participant had participated in Experiment 2.

Materials and Procedure

Materials and procedure were the same as in Experiment 2, with only one change. In Experiment 2, distractor and picture were presented simultaneously (SOA 0). In Experiment 3, the distractors were presented 200 ms after the onset of the picture (SOA +200 ms).

Results

Erroneous responses (5.6%) and extreme reaction times (0.5%) were treated in the same way as in Experiments 1 and 2. Table 3 shows the mean utterance onset latencies as a function of verb type (intransitive versus transitive verbs), word order (verb-last versus verb-first), and distractor conditions.

The results were analyzed in the same way as in Experiment 2. The overall analyses of variance with the factors of verb type, word order, and distractor condition showed main effects of all three factors (verb type: $F1(1,15) = 20.9$, $p < .005$, $MS_e = 6079$, $F2(1,22) = 2.9$, $p = .10$, $MS_e = 32299$; word order: $F1(1,15) = 28.6$, $p < .0005$, $MS_e = 20398$, $F2(1,22) = 27.3$, $p < .005$, $MS_e = 16020$; distractor condition: $F1(4,60) = 9.3$, $p < .005$, $MS_e = 8283$,

F2(4,88) = 22.1, $p < .005$, $MS_e = 2624$). In addition, the interactions of word order and distractor condition (F1(4,60) = 4.4, $p < .01$, $MS_e = 3684$, F2(4,88) = 6.6, $p < .01$, $MS_e = 1825$) and of verb type and distractor condition (F1(4,60) = 7.2, $p < .005$, $MS_e = 1891$, F2(4,88) = 3.9, $p < .01$, $MS_e = 2624$) were significant. The triple interaction between the three factors was also significant (F1(4,60) = 4.4, $p < .01$, $MS_e = 1583$, F2(4,88) = 2.9, $p < .05$, $MS_e = 1825$).

As in Experiment 2, this pattern was explored further in separate analyses of variance for the picture set with intransitive verbs and the picture set with transitive verbs, with the factors of word order and distractor condition. For the picture set with intransitive verbs, both main effects were significant (word order: F1(1,15) = 19.5, $p < .005$, $MS_e = 14041$, F2(1,11) = 10.5, $p < .01$, $MS_e = 19594$; distractor condition: F1(4,60) = 8.2, $p < .01$, $MS_e = 4522$, F2(4,44) = 9.8, $p < .01$, $MS_e = 2830$). The interaction between the two factors was not significant (F1(4,60) = 1.1, $p = .35$, $MS_e = 2354$, F2(4,44) = 1.5, $p = .22$, $MS_e = 1644$). By contrast, for the picture set with transitive verbs, both main effects and their interaction were significant (word order: F1(1,15) = 33.6, $p < .005$, $MS_e = 9247$, F2(1,11) = 18.7, $p < .01$, $MS_e = 12476$; distractor condition: F1(4,60) = 9.5, $p < .005$, $MS_e = 5651$, F2(4,44) = 16.7, $p < .005$, $MS_e = 2418$; interaction: F1(4,60) = 8.3, $p < .005$, $MS_e = 2393$, F2(4,44) = 7.4, $p < .01$, $MS_e = 2007$). Duncan tests (by subjects and by items, $p < .05$), for each of the four combinations of verb type and word order separately, showed the following pattern of significant differences between the distractor conditions. For utterances with intransitive verbs in final position (subject–verb) the NONE condition had longer utterance onset latencies than the remaining four conditions which did not differ from each other. The same pattern obtained for utterances with intransitive verbs in initial position (verb–subject) and for utterances with transitive verbs in final position (subject–object–verb). For the utterances with transitive verbs in initial position (verb–subject–object), by contrast, the Duncan tests showed the following pattern of significant differences. The IDENTICAL condition had shorter naming latencies than any of the remaining four distractor conditions. The UNR condition had shorter naming latencies than the NONE, SEM and SYN conditions. No other differences reached significance. Most important for our present purpose are the significant semantic interference effect (SEM vs UNR, 78 ms) and the significant inhibition effect from distractors having different subcategorization frames (SYN vs UNR, 61 ms).

No significant differences were obtained in analyses of erroneous responses, with one exception. For verb-initial utterances with transitive verbs, the number of erroneous responses in the SEM condition (12.7%) was significantly higher than in the remaining four distractor conditions. This higher error percentage was primarily due to more filled pauses preceding utterance initiation and more (self-corrected) usage of nontarget verbs. Finally, as in Experiment 3, the percentage of within-utterance pauses and hesitations did not differ between verb-last and verb-first utterances (2.1 and 2.3%, respectively), corroborating the conclusion from Experiment 2 that speakers were not simply blurting out the subject noun in case of verb-last utterances.

Discussion

Experiment 3 replicated and extended the main results of Experiment 2. Before turning to the specific results of Experiment 3, we must address one general difference between the results of Experiments 2 and 3.

In Experiment 2 (SOA 0 ms), the NONE condition gave consistently shorter naming latencies than did the conditions with distractor verbs. This is the usual pattern found in comparable studies and appears to indicate a general unspecific interference effect in the presence of any distractor word. In Experiment 3, in contrast, the NONE condition yielded utterance onset latencies that were longer or about equal to the utterance onset latencies in the conditions with distractor verbs. The reason for this difference in results is not clear. However, we assume that the saliency of distractors due to their double

presentation (visual and auditory) might have induced a tendency to wait for the distractors. In the NONE condition for SOA 200, speakers might therefore have waited somewhat longer than in the conditions with distractors. This could also imply that the distractors were attended to more in the present experiment than in Experiment 2. It might be that this situation, and not the SOA of +200 ms, is responsible for the fact that a SYN effect was obtained in the present experiment, but not in Experiment 2. We will return to this possibility in Experiment 4.

Let us next move to the results for utterances with intransitive verbs. As in Experiment 2, we did not obtain any specific effects of the distractor conditions for target utterances with intransitive verbs. There appears to be something about these utterances that blocks any specific effects of the distractor conditions. For utterances with transitive verbs, both word orders induced by the respective lead-ins (subject–object–verb, verb–subject–object) differ from the canonical word order of the corresponding German main clauses (subject–verb–object). In contrast, for utterances with an intransitive verb, the subject–verb word order is not only the word order induced by the lead-in (and thus the word order to be used in half of these utterances in the present experiment), but it is also the canonical word order for German main clauses with an intransitive verb. This might have induced speakers to plan a subject–verb sentence by default as soon as they saw a picture with an actor and an action, but without an object for the action. The alternative word order, verb–subject, would then be derived from the canonical word order in a second step if the lead-in required this. Hence, the following sequence of processes might be responsible for the null results for utterances with intransitive verbs. The lemma for the subject noun is available before the lemma for the (intransitive) verb (see Experiment 1). According to recent models of incremental grammatical encoding (see deSmedt, 1996), speakers assign the corresponding noun lemma to the first position of the utterance, its default position in the canonical word order. In a next step, the speaker checks whether this assignment to the first position is correct given the lead-in. If so, grammatical planning processes can proceed in their usual manner. If the lead-in requires the (noncanonical) order verb–subject, the noun lemma has to be reassigned to the second position in the eventual utterance. While these checking and reassignment processes are carried out, the verb can presumably be retrieved successfully. If the assumed checking and reassignment processes take more time than the (parallel) retrieval of the verb lemma (whether interfered with or not), interference with the retrieval of the verb lemma will not be reflected in utterance onset latencies. Although this account is speculative, it can explain the overall null effects of the specific distractor conditions for utterances with intransitive verbs.

As we mentioned above, for target utterances with transitive verbs, neither format (subject–object–verb, verb–subject–object) coincides with the canonical word order of corresponding main clauses (subject–verb–object). This might have blocked any tendency to proceed by default via the canonical word order. Rather, speakers directly aimed at the word order induced by the respective lead-in.

This leads to an important question concerning the function of the lead-in fragments. Do the lead-in fragments induce a mode of grammatical planning which is not representative of normal production? Is it possible that the advance planning unit for sentences does normally include the verb lemma and that the results of Experiments 2 and 3 reflect the presence of the lead-in which gives an advance cue as to the eventual word order? This question is addressed in Experiment 5.

As in Experiment 2, interference with the retrieval of the verb (SEM) affected utterance onset latencies for utterances with transitive verbs only if the verb occurred in utterance initial position. This suggests that, at least in the presence of word order cueing lead-in fragments, the grammatical advance planning unit does not contain the target verb by default. For verb-final utterances, speakers appear to be able to assign the noun lemmas to their respective syntactic functions (subject and direct object)

without using the verb's subcategorization frame and argument structure.

However, Experiment 3 also showed an interference effect from distractor verbs having a subcategorization frame that mismatches the target verb (SYN vs UNR conditions). Again, this effect was only observed for utterances with verb-initial position. It appears that speakers can assign syntactic functions without knowing the verb lemma and its subcategorization frame and argument structure, and they do so if the verb does not occur in utterance initial position. On the other hand, if the verb occurs in sentence initial position, the verb's subcategorization frame plays a role in grammatical encoding, as reflected in the effect of the SYN condition. However, we obtained a significant effect of the SYN condition only in Experiment 3. Therefore, the next experiment aimed at replicating this effect. In addition, the next experiment aimed at tracing potential artifacts due to the extensive preexposure to and repetition of pictures in Experiments 2 and 3.

EXPERIMENT 4

Experiment 4 was a replication of Experiment 2 with reduced preexposure of the critical pictures. In Experiments 2 and 3, participants went through three experimental stages. First, they were presented a booklet with the critical pictures and the words to be used in the description. Then, they saw each picture four times, with the instruction to name only the actor, only the action, or to describe the picture according to the two lead-in sentences. Only then did the experimental task with picture description under different distractor conditions start. Thus, the pattern of results obtained in Experiments 2 and 3 could, at least in part, be due to the extensive preexposure of the critical pictures. The present experiment specifically addressed two issues concerning potential effects of preexposure.

First, in Experiments 2 and 3, participants had already used each verb twice in sentential descriptions (while participating in Experiment 1) before they entered the experimental stage with distractor presentation. This implies that they have already twice assigned the respective nouns to grammatical functions. This repeated use of the verbs in sentence production presumably renders a verb lemma's subcategorization information more easily accessible. Jescheniak and Levelt (1994) proposed that recent access to a noun's grammatical gender facilitates the lemma-to-gender connection after which it only slowly decays. This facilitation could be of value in the production of (gender marked) pronominal reference (see Jescheniak & Levelt, 1994; but see van Berkum, 1997). Similarly, recent use of a verb in a sentence might make the verb's subcategorization information more accessible, and this might have a function for the production of elliptical utterances with the verb as the elided element (see Schmitt, 1997). For example, in an utterance like "Der Mann (nom.) hilft der Frau (dat.), und der Junge (nom.) dem Mädchen (dat.)" (the man helps the woman, and the boy the girl), the subcategorization information of the verb "help" has to be available during the planning of the second part of the utterance in order to assign dative case to the noun phrase "dem Mädchen." Hence, one could hypothesize that, after extensive previous use of the verb in sentence production, the verb's subcategorization information is so easily accessible that a reliable SYN interference effect cannot be obtained. Therefore, in Experiment 4 we skipped the second stage of Experiment 2; right after the familiarization stage (the presentation of the booklet), participants began with the picture word interference experiment.

The second issue concerns potential artifacts due to the repeated presentation of each picture in each of the distractor conditions. In order to control for such potential artifacts, Experiment 4 contained an additional control factor (see below).

Participants

Sixteen new participants, drawn from the same pool as in the preceding experiments, participated.

Materials and Procedure

Materials and procedure were the same as in Experiment 2 except for two changes. First, in

order to control for potential effects of the repetition of pictures in the different distractor conditions, four experimental versions of the list of trials were constructed. This was done such that we could specify an additional control factor Block for the four conditions with distractors. If repetition of pictures has a significant influence on the pattern of results, we would expect interactions of the control factor Block with the other factors.

Each experimental version consisted of four blocks of trials. For the set of the 12 pictures with transitive verbs, each verb occurred twice per block, once with each of the two lead-in fragments. For the first lead-in fragment, the 12 pictures were divided into 4 subsets of 3 pictures each. These four subsets were assigned to the SEM condition, the UNR condition, the SYN condition, and the IDEN condition, respectively. Finally, a random selection of three pictures also occurred in the NONE condition. The same assignment of pictures to the distractor conditions was repeated for the second lead-in fragment. However, the subsets of 3 pictures were assigned to different distractor conditions than with the first lead-in fragment. For the remaining 3 blocks, the assignment of subsets of pictures to distractor conditions was rotated such that across the 4 resulting blocks each picture contributed once to each distractor condition. The same procedure was applied to the set of pictures with transitive verbs. For each of the resulting 4 blocks of 60 trials, a different randomization was determined under the same restrictions as in Experiments 2 and 3.

From the resulting four blocks, four experimental versions were derived by systematically varying the presentation order of the four blocks in the experimental versions, such that across experimental versions each block occurred once in each order position. Four participants were run on each of the four experimental versions.

The second change concerned the amount of familiarization with the target pictures. As already mentioned, the second stage of Experiments 1 and 2 (picture naming without distractors, i.e., Experiment 1) was skipped in the present experiment.

Results

Erroneous responses (14.0%) and extreme reaction times (1.5%) were treated in the same way as in Experiments 1 through 3. Table 4 shows the mean utterance onset latencies as a function of verb type (intransitive versus transitive verbs), word order (verb-last versus verb-first), and distractor conditions.

The results were analyzed in the same way as in the preceding experiments except that the additional control factor Block was included. This control factor showed a marginally significant main effect ($F(3,45) = 2.4$, $p < .10$) which is due to the fact that response latencies become somewhat shorter over the four blocks. None of the other factors showed an interaction with the factor block (all F's smaller 1), indicating that the pattern of results was stable across blocks and thus across repetitions of pictures in the different distractor conditions. The main effects of the factors of verb type, word order, and distractor condition were significant (verb type: $F1(1,15) = 47.5$, $p < .005$, $MS_e = 16948$, $F2(1,22) = 5.2$, $p < .05$, $MS_e = 38330$; word order: $F1(1,15) = 21.2$, $p < .0005$, $MS_e = 5591$, $F2(1,22) = 19.4$, $p < .005$, $MS_e = 13893$; distractor condition: $F1(4,60) = 2.9$, $p < .05$, $MS_e = 5029$, $F2(4,88) = 3.6$, $p < .01$, $MS_e = 3086$). The interaction between word order and verb type was also significant ($F1(4,60) = 5.2$, $p < .01$, $MS_e = 2586$, $F2(4,88) = 3.2$, $p < .05$, $MS_e = 1988$). The triple interaction between the three factors was marginally significant in the subject analysis, but did not reach significance in the item analysis ($F1(4,60) = 2.2$, $p < .10$, $MS_e = 2192$, $F2(4,88) = 1.7$, $p = .15$, $MS_e = 1988$). Finally, the interaction of word order and verb type and of word order and distractor condition did not reach significance (all Fs smaller than 1).

As in Experiments 2 and 3, separate analyses of variance for the picture set with intransitive verbs and the picture set with transitive verbs were carried out, with the factors of word order and distractor condition. For the picture set with intransitive verbs, the main effect of word order was significant ($F1(1,15) = 30.9$, $p < .005$, $MS_e = 6763$, $F2(1,11) = 9.3$, $p < .05$, $MS_e =$

TABLE 4

Mean Utterance Onset Latencies for Descriptions with Transitive Verbs and Intransitive Verbs as a Function of Word Order and Distractor Condition in Experiment 4

		Distractor condition				
Verb type	Word order	SEM	UNR	SYN	IDENT	NONE
Intransitive	S-V	786	791	792	789	773
		(13.8)	(14.2)	(15.6)	(14.3)	(12.2)
		[142]	[143]	[134]	[149]	[134]
	V-S	850	856	852	890	845
		(14.5)	(16.2)	(13.8)	(10.7)	(15.6)
		[132]	[140]	[135]	[185]	[122]
Transitive	S-O-V	868	859	860	841	818
		(17.2)	(15.7)	(14.8)	(14.8)	(12.9)
		[206]	[171]	[174]	[170]	[136]
	V-S-O	947	910	947	884	867
		(18.0)	(15.5)	(15.4)	(13.6)	(14.0)
		[137]	[143]	[174]	[133]	[127]

Note. Percentage of erroneous responses in parentheses; standard deviations in square brackets.

16784). Neither the main effect of distractor condition ($F1(4,60) = 1.1$, $p > .30$, $MS_e = 3425$, $F2(4,44) = 1.03$, $p > .40$, $MS_e = 2800$) nor the interaction between the two factors ($F1(4,60) < 1$, $F2(4,44) < 1$) was significant. By contrast, for the picture set with transitive verbs, both main effects and their interaction reached significance (word order: $F1(1,15) = 11.3$, $p < .005$, $MS_e = 13369$, $F2(1,11) = 10.3$, $p < .01$, $MS_e = 11002$; distractor condition: $F1(4,60) = 5.8$, $p < .01$, $MS_e = 4190$, $F2(4,44) = 5.4$, $p < .01$, $MS_e = 3363$; interaction: $F1(4,60) = 2.5$, $p < .05$, $MS_e = 1586$, $F2(4,44) = 2.6$, $p < .05$, $MS_e = 2257$).

Duncan tests (by subjects and by items, $p < .05$) for each of the four combinations of verb type and word order separately showed that, for utterances with intransitive verbs in final position (subject–verb) as well as in initial position (verb–subject), there were no significant differences. For utterances with transitive verbs in final position, the NONE condition had shorter utterance onset latencies than did the conditions SEM, UNR, and SYN, which did not differ from each other. For the utterances with transitive verbs in initial position (verb–subject–object), the NONE condition had shorter naming latencies than did the SEM, SYN and UNR conditions. The IDENTICAL condition had shorter naming latencies than the SEM and the SYN condition. Finally, the UNR condition had shorter naming latencies than the SEM and SYN conditions. No other differences reached significance.

The overall number of errors was higher than in Experiments 2 and 3, presumably because participants were less familiar with the pictures than in Experiments 2 and 3. No significant differences between the experimental conditions were obtained in analyses of errors. As in the preceding experiments, the percentage of within-utterance pauses and hesitations did not differ between verb-last and verb-first utterances.

Discussion

The present experiment provides a replication of the semantic interference effect for verb-first utterances with transitive verbs, as well as of the absence of a semantic interference effect for utterances with transitive verbs in sentence final position. Also, the null effects for utterances with intransitive verbs are replicated. This pattern has proved to be reliable across three experiments, including the present experiment

with reduced preexperimental familiarization of participants with the pictures.

The inhibition effect of the SYN condition appears to be more fragile, as reflected by the fact that it obtained in Experiments 3 and 4, but not in Experiment 2. In Experiment 2, participants were trained on the picture descriptions before the main experiment started, whereas this was not the case in Experiment 4. This may explain why Experiment 2 only yielded an insignificant 17 ms inhibition effect of the SYN condition, whereas Experiment 4 yielded a significant 37 ms inhibition effect. Repeated previous use of a verb in sentence production may reduce the effect in a way similar to the "gender recency" effect observed by Jescheniak and Levelt (1994).

However, other aspects of the results suggest that the pure number of repetitions is not the only factor. If it were, one would also expect the inhibition effect of the SYN condition to diminish over the successive blocks of Experiment 4, yielding a block by distractor condition interaction. The fact that we did not obtain such an interaction might be due to insufficient statistical power. However, we did not observe any consistent trend for a decrease of the inhibition effect of the SYN condition over the course of the experiment. Therefore, it appears that explicit training preceding the picture–word interference experiment is of greater importance than the number of repetitions of pictures within the picture–word interference experiment. Note, however, that we did obtain a syntactic interference effect in Experiment 3 which, like Experiment 2, included an extensive training preceding the picture–word interference experiment. But Experiment 3 also suggested that, with an SOA of +200 ms, the distractor words in their double presentation mode (visual and auditory) are attended to more than in the other experiments, presumably strengthening the impact of the distractors.

Whatever the precise conditions under which a syntactic interference effect can be obtained, the present experiments show that the semantic interference effect and the syntactic interference effect are only obtained for verb-first utterances with transitive verbs.

The pattern of utterance onset latencies strongly suggests that, for sentences with the verb in final position, speakers do not have to have completed selection of the verb lemma before initiating articulation. This implies that selection of the verb lemma is completed during articulation. Does this have effects on the way the utterance is produced? For example, in verb-last utterances speakers might need additional time for the selection of the verb lemma. This could surface in a larger number of pauses and hesitations in verb-last sentences, particularly in the condition with semantically related distractors inhibiting verb lemma selection. As we saw above, there is no evidence for such an increase of the number of pauses and hesitations in the respective experimental conditions.

However, subtle prolongations of articulation spread across fluent stretches of speech could have a similar function as pauses and hesitations. In this case, we should find systematic effects of the experimental conditions on utterance durations. To test for this possibility, we digitized the tape recordings of the experimental sessions of the present experiment and measured the durations of those utterances which had been included in the analyses of the utterance onset latencies. Two questions concerning the articulation durations are of interest. First, are the effects of distractor conditions on utterance onset latencies for verb-first sentences mimicked by corresponding effects on utterance durations for verb-last sentences? In verb-last sentences, speakers can try to compensate for a slowing of verb lemma retrieval by longer utterance durations, thus creating additional time for selection of the verb lemma. Second, are utterance durations in verb-last utterances systematically longer than in verb-first utterances? This might be the case if speakers create additional time for selection of the verb lemma while articulating the beginning parts of the utterance.

The utterance durations for utterances with intransitive and transitive verbs were analyzed in separate analyses of variance with the factors of word order and distractor condition. For utterances with intransitive verbs, the factor of distractor condition was significant ($F1(4,60) =$

7.2, $p < .2005$, $MS_e = 429$, F2(4,44) = 9.07, $p < .005$, $MS_e = 513$). Neither the factor of word order nor the interaction between distractor condition and word order was significant (word order: F1(1,15) = 1.45, $p = .25$, $MS_e = 3162$, F2(1,11) = 1.37, $p = .27$, $MS_e = 4992$; interaction: F1(4,60) < 1, F2(4,44) < 1). The same pattern was obtained for utterances with transitive verbs. The factor of distractor condition was significant (F1(4,60) = 3.9, $p < .001$, $MS_e = 1120$, F2(4,44) = 11.9, $p < .005$, $MS_e = 545$). Neither the factor of word order nor the interaction of word order and distractor condition reached significance (word order: F1(1,15) = 2.8, $p = .11$, $MS_e = 5003$, F2(1,11) = 2.5, $p = .14$, $MS_e = 8444$; interaction: F1(4,60) < 1, F2(4,44) < 1). Post hoc tests (Duncan, $p < .05$) showed that the main effect of distractor condition was due to shorter utterance durations in the condition without a distractor than in the remaining distractor conditions, which did not differ significantly from each other. Presumably, speakers tend to speak a little louder in the presence of a (auditorily and visually presented) distractor which might lead to a slight increase in utterance durations. However, we did not find any indication that the pattern of utterance durations in verb-last utterances paralleled the pattern of utterance onset latencies in verb-first utterances. Thus, when producing a verb-last utterance in presence of a distractor slowing verb lemma retrieval, speakers do not generate additional processing time by longer utterance durations.

We now turn to the final experiment. We have speculated that the absence of semantic or syntactic interference effects for utterances with intransitive verbs could be due to the fact that one of the two lead-in fragments required a word order which was also the canonical word order for main clauses with intransitive verbs. This leads to the more general question of whether the word order cueing lead-in fragments induce a planning strategy different from that used in the absence of lead-in fragments. If the restriction of verb interference effects to utterances with the verb in initial position is induced by the presence of the word order cueing lead-in sentences, then we would expect that, in the absence of lead-in fragments, verb interference effects also obtain for utterances with the verb in noninitial position.

EXPERIMENT 5

Experiment 5 was a replication of Experiment 2, except that participants did not hear any lead-in fragments. Rather, they described the pictures by simple main clauses in canonical word order (i.e., subject–verb or subject–verb–object).

Participants

Sixteen native speakers of German drawn from the same pool as in the preceding experiments participated.

Materials and Procedure

Materials and procedure were the same as in Experiments 2 and 3, except for the following changes. First, pictures were not preceded by lead-in fragments. Second, the randomization was determined as in Experiments 2 and 3, except that the restrictions concerning the lead-in fragments did, of course, not apply. As in Experiment 2, distractors were presented at an SOA of 0 ms.

Results

Erroneous responses (7.8%) and extreme reaction times (0.2%) were treated as in Experiments 2 and 3. Table 5 gives the mean utterance onset latencies for main clauses with intransitive verbs and transitive verbs as a function of distractor conditions.

Analyses of variance with the factors of verb type (intransitive versus transitive) and distractor condition showed main effects of both factors, but no significant interaction (verb type: F1(1,15) = 37.9, $p < .005$, $MS_e = 2430$, F2(1,22) = 4.6, $p < .05$, $MS_e = 15020$; distractor condition: F1(4,60) = 15.9, $p < .005$, $MS_e = 2284$, F2(4,88) = 13.3, $p < .005$, $MS_e = 2050$; interaction: F1(4,60) < 1, F2(4,88) < 1). Duncan tests ($p < .05$) showed that, for utterances with intransitive verbs, the NONE condition had significantly shorter utterance onset latencies than did the remaining four conditions. The IDENTICAL condition had shorter latencies than the SEM condition. No other differences reached significance. For the utterances

TABLE 5

Mean Utterance Onset Latencies for Descriptions with Main Clauses with Intransitive or Transitive Verbs as a Function of Distractor Condition in Experiment 5

	Distractor condition				
Verb type	SEM	UNR	SYN	IDENT	NONE
Intransitive	837	827	827	799	742
	(9.4)	(7.8)	(7.8)	(7.8)	(6.8)
	[137]	[149]	[119]	[111]	[109]
Transitive	869	868	879	850	805
	(9.9)	(9.9)	(8.3)	(7.3)	(2.6)
	[115]	[141]	[154]	[122]	[129]

Note. Percentage of erroneous responses in parentheses; standard deviations in square brackets.

with transitive verbs, the NONE condition had shorter utterance onset latencies than the remaining four conditions which did not differ significantly from each other.

Analyses of errors showed one significant difference. For utterances with transitive verbs, the overall percentage of errors in the NONE condition was significantly lower than in the remaining four distractor conditions. The percentage of utterances with within-utterance hesitations was comparable to that of the preceding experiments (2.4% for transitive verbs, 2.6% for intransitive verbs).

Discussion

For the production of main clauses, i.e., in the absence of any word order cueing lead-in fragment, we did not obtain any evidence for verb interference effects. This is the pattern of results obtained in Experiments 2 and 3 for utterances with verb-final position. Thus, the absence of verb interference effects for verb-final utterances in Experiments 2 and 3 was not due to the presence of the lead-in fragments. These results indicate that, for the utterances in the present experiments, the verb is only part of the grammatical advance planning unit if it occurs in sentence initial position. If the verb occurs in a noninitial position, the verb lemma does not have to be retrieved before initiation of the utterance.

GENERAL DISCUSSION

The present experiments investigated the role of the verb in the grammatical planning of simple sentences. We contrasted two hypotheses. According to the first hypothesis, which derives from the assumption of lexical guidance of grammatical encoding, the verb lemma and its associated syntactic information play a central role in the assignment of conceptual event roles to grammatical functions. In its strongest version, this hypothesis predicts that grammatical function assignment is always mediated by the verb lemma's syntactic information. According to the competing hypothesis, grammatical encoding can largely be guided by the conceptual input. In particular, the rather high correlation between properties of lexical concepts and conceptual event roles on the one hand and grammatical functions on the other hand can be exploited for grammatical function assignment. Hence, the verb lemma's syntactic specifications are not necessarily needed for grammatical function assignment.

Our results show that the verb is not an obligatory part of the grammatical advance planning unit. However, the present study and related evidence also suggest that the verb lemma's syntactic specifications can play a central role in grammatical encoding. Thus, it appears reasonable to assume that grammatical encoding is neither exclusively conceptually nor exclusively lexically driven. Rather, there appear to be two alternative routes to grammatical function assignment, one

driven by conceptual information and one driven by the verb's syntactic properties.

In German, the language studied in the present experiments, grammatical function assignment implies a decision about the grammatical case of the noun phrases which in turn determines their phonological shape. Hence, the lexical guidance hypothesis predicts that articulation of a sentence or clause cannot be initiated before the verb lemma and its syntactic properties have been retrieved. The conceptual guidance hypothesis, in contrast, allows for grammatical function assignment independent of the verb lemma, and thus for initiation of articulation of a sentence or clause before the verb lemma has been retrieved.

In three picture–word interference experiments (Experiments 2 through 4), we systematically varied the verb's position (sentence-initial versus sentence-final) in sentences with intransitive and transitive verbs. For sentences with intransitive verbs, we did not observe any specific interference effects, and this null effect was replicated in all three experiments. A tentative explanation for this null result was proposed in terms of the relation between the canonical word order in German main clauses and the actual word orders to be produced in these experiments.

For sentences with transitive verbs, we obtained a robust semantic interference effect in all three experiments. However, this effect was confined to utterances with the verb in initial position. For utterances with verbs in final position, no such effects were found. Even on a descriptive level, Experiments 2 and 3 yielded the opposite of a semantic interference effect (−10 and −11 ms, respectively) for verb-final utterances with transitive verbs, and Experiment 4 showed only a very small trend for a semantic interference effect (9 ms), which was far from significant. For Experiments 2 and 3, one might suspect that the difference between verb-initial and verb-final utterances occurred because participants had extensive preexposure to the critical pictures. However, Experiment 4, with reduced preexposure to the pictures, replicated the results of Experiments 2 and 3. Furthermore, the pattern of within-utterance hesitations and pauses, and an analysis of utterance durations (Experiment 4) showed that speakers were not "over-hastily" starting verb-final utterances with the subject noun phrase. Taken together, these results show that, in the present experiments, speakers can produce fluent utterances with the verb in final position without having selected the verb lemma.

These results suggest that grammatical function assignment is not automatically and obligatorily driven by the syntactic information associated with the verb lemma. But how can speakers assign grammatical functions in the absence of the verb lemma and its associated subcategorization and argument structure information? There is a strong and, as Bock and Levelt (1994) put it, seductive correlation between semantic-conceptual features of lexical concepts (in particular, animacy and concreteness) and the grammatical function of the corresponding lemmas in the eventual utterance. In particular, animate entities have a strong tendency to be assigned to the function of grammatical subject. This correlation is not only seductive from a theoretician's point of view, but presumably also useful for the speaker. For the utterances of the present experiments, this correlation was perfect; all animate entities always ended up in subject function, and all inanimate entities in the function of direct object. Thus, within our experimental setting, the repetition of a small set of syntactic structures allows for the formation of a small number of sentence frames (e.g., Bock & Loebell, 1990), and the animacy values of the event participants guarantee the correct assignment of lemmas to grammatical functions in these sentence frames. This may explain why speakers can initiate a fluent utterance without having completed retrieval of the verb lemma.

So far, the evidence suggests that grammatical function assignment is driven by conceptual information. However, the syntactic interference effect for verb-initial utterances with transitive verbs obtained in Experiments 3 and 4 suggests that syntactic information associated with the verb lemma also plays a role in grammatical function assignment. This result shows that *if* the verb lemma has become available before utterance onset (as is necessarily the case for verb-first utterances), then its associated syntactic information is used in grammatical encoding. Note that the perfect correlation between semantic-conceptual features and gram-

matical functions in the present experiments would allow a speaker to assign grammatical functions without taking into account a verb lemma's subcategorization information, irrespective of whether the verb was in final or in initial position. The syntactic interference effect for verb-first utterances, however, suggests that grammatical function assignment is, at least in part, driven by the verb lemma's syntactic information if the verb lemma has become available before utterance onset.

We propose that in the case of verb-initial utterances with a transitive verb, the syntactic information of the intransitive distractor sets up a subcategorization frame that does not include a slot for the grammatical function of a direct object. However, the to-be-produced target verb requires that one of the lexical concepts is assigned to this grammatical function. The resulting competition between these two subcategorization frames leads to a prolongation of utterance onset latencies. This interpretation is parallel to the interpretation of the so-called gender congruency effect which has been obtained in picture word interference experiments examining the production of gender-marked noun phrases (e.g., LaHeij et al., in press; Schriefers, 1993; van Berkum, 1997).

The syntactic interference effect obtained for utterances with initial transitive verbs suggests that, even if the correlation between semantic-conceptual features and grammatical functions is perfect, speakers do not rely exclusively on this correlation. For utterances with the verb in final position, there are also some (statistically nonsignificant) trends in the data which suggest that speakers do not exclusively rely on the correlation between semantic-conceptual features of lexical concepts and their grammatical function. These trends suggest that, in line with the lexical guidance hypothesis, the verb lemma is, in a small proportion of trials, part of the advance planning unit, even if the verb does not occur in utterance-initial position. This is most obvious for the comparison of the condition with identical distractors and unrelated distractors. For utterances with the verb not occurring in initial position, we found a small and insignificant, but nevertheless consistent facilitation effect for the identical condition across Experiments 2 through 5. For utterances with intransitive verbs, these facilitation effects ranged from 2 (Experiment 4) to 32 ms (Experiment 3) and for utterances with transitive verbs from 18 (Experiments 4 and 5) to 23 ms (Experiment 3).

In summary, the present results suggest a dual-route model of grammatical function assignment in sentence production. Grammatical function assignment can either be driven by conceptual information or by the verb lemma's syntactic properties. This view converges with our reading of the proposal made by Bock and Levelt (1994). There are semantic-conceptual influences on grammatical encoding, as well as influences from the syntactic specification of the verb lemma, notably its subcategorization and argument structure information. Which of the two routes is used will depend on a number of factors. These factors will presumably include, among others, the temporal order in which different parts of the conceptual input and their corresponding lemmas become available, the reliability of the correlation between semantic-conceptual features and grammatical functions, and the degree to which sentences with parallel syntactic structures are produced in direct succession. Future research should focus on the factors determining which of these routes is used.

APPENDIX 1

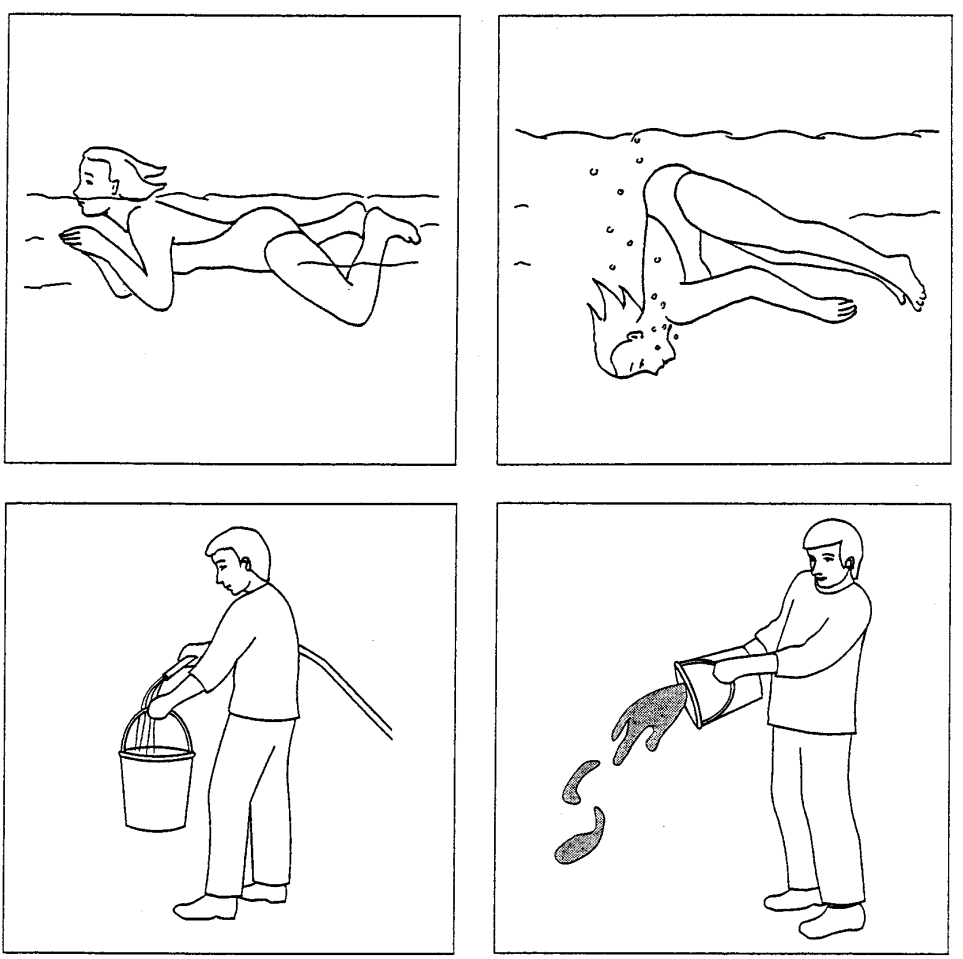
Target verbs used in Experiments 1 through 5, with approximate English translations. For a given target verb, the other verb of the respective pair served as the distractor in the SEM condition of Experiments 2 through 5. The distractor for the UNR condition was selected from a different pair of the same set of verbs (transitive or intransitive). For the SYN condition, the distractor was selected from the other set (e.g., target from transitive set, distractor from intransitive set).

Verb type	Verb pairs
Intransitive verbs	schwimmen–tauchen (swim) (dive, swim under water) lachen–weinen (laugh) (cry)

Verb type	Verb pairs	Verb type	Verb pairs
	stehen–knien (be upright) (be on one's knees)		öffnen–schließen (Tür) (open) (close) (door)
	springen–fallen (jump) (fall)		erhitzen–kühlen (Milch) (heat) (cool) (milk)
	niesen–husten (sneeze) (cough)		füllen–leeren (Eimer) (fill) (empty) (bucket)
	sprechen–schweigen (speak) (stay silent)		schieben–ziehen (Tisch) (shove aside) (drag, pull) (table)
Transitive verbs	werfen–fangen (Ball) (through) (catch) (ball)		lesen–schreiben (Brief) (read) (write) (letter)

APPENDIX 2

Example Pictures for Descriptions with Intransitive Verbs (Top Row: "to Swim"—"to Dive") and Transitive Verbs (Bottom Row: "to Fill Bucket"—"to Empty Bucket")



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