Lost in Thought: Cognitive Load and the Processing of Addressees' Feedback in Verbal Communication

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Abstract. Two experiments tested if cognitive load interferes with perspective-taking in verbal communication even if feedback from the addressee is available. Participants gave instructions on the assembly of a machine model. In Experiment 1, cognitive load was demonstrated to be a function of the complexity of assembly steps. In Experiment 2, position of feedback (during simple vs. during complex steps) and type of feedback (question vs. ambiguous interjection) were manipulated. With simple steps, speakers' responses were a function of feedback type. Speakers responded differently to questions than to interjections. With complex steps, however, responses were a function of cognitive load. Regardless of the type of feedback, most speakers simply repeated their previous utterances.

Key words: verbal communication, human channel capacity, role-taking

It is almost a truism to say that speakers speak "to satisfy their listener's reasons for listening" (Clark & Clark, 1977, p. 31). They tailor their speech to their particular listener by intending "each addressee to base his (sic) inferences … only on their *mutual* knowledge or beliefs – their common ground" (Clark, 1992, p. 81). The study of Isaacs and Clark (1987) illustrates this *optimal design principle*: speakers with expertise of New York City landmarks adapted their references to their listeners' knowledge (e.g., by supplementing a landmark's name with a description to facilitate identification). Beyond the lexical level, such adaptation also comprises dimensions like syntax and prosody (for overviews, see Blakar, 1979, Clark, 1985, Coupland, Coupland, & Giles, 1991, Dell & Brown, 1991, Krauss & Fussell, 1996). "Motherese" (e.g., Newport, 1976) or "Elderspeak" (e.g., Cohen & Faulkner, 1986) are well-known examples of such *perspective-taking* that lies at the heart of successful communication (cf. Schober, 1998).

Despite its importance, perspective-taking is not as unconditional as one might expect. In Schober's (1993, 1995) studies, speakers preferred egocentric expressions in a spatial perspective task although they conversed with a partner. Speakers adapted their descriptions of locations on a complex display to their addressees' vantage point if it was offset by 90°, but not to an offset of 180° (Schober, 1995). In the spatial object-identification tasks of Buhl (1996), most speakers disregarded that the addressee could not see the described object from his/her perspective – which resulted in uncommunicative descriptions. Similarly, Speck's (1995) participants did not adapt their description of a model object to their listener's perspective. Finally, Roßnagel (1995) had Karate instructors explain the same Karate technique to both a group of novices and of advanced students. Despite substantial differences in their listeners' knowledge, speakers gave almost identical instructions to both groups.

Horton & Keysar (1996) proposed a *monitoring and adjustment model* that accommodates the afore-

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mentioned findings. In that model, perspective-taking is a two-step process. As a first step, an initial utterance plan is generated and information integrated into that plan is selected according to its cognitive availability – rather than to the listener's information needs. In a second step, correction mechanisms adjust utterance plans that are not fully communicative. The authors posited that the knowledge involved in taking the listener's perspective might be "too costly for the system to incorporate routinely in every utterance plan. By making common ground part of a correcting mechanism the system might save some resources" (p. 112).

In line with the monitoring and adjustment model, speakers in the study of Roßnagel (2000) study adapted their instructions on the assembly of a machine model if they had the model at hand – but failed to do so when they had to recall the assembly from memory or carried out a secondary task. This *cognitive load effect* on perspective-taking resulted from cognitive resources being usurped by the recall of relevant information from memory. Virtually no capacity was left for adjusting utterances to the addressee's perspective. This explanation might also apply to the findings of Schober (1993, 1995), Buhl (1996) and Speck (1995). The spatial nature of their tasks required participants to mentally transform complex objects, a task that had previously been shown to induce considerable cognitive load (e.g. Rock, Wheeler & Tudor, 1989).

The purpose of the present paper is to extend research on the cognitive load effect to settings including feedback from the addressee. Whilst several studies (e.g., Jou & Harris, 1992, Power, 1985, Roßnagel, 2000) have investigated cognitive load effects on speech production, generalization to perspective-taking is limited because communication was stripped of its social context to the extent that no addressees were present or that feedback was disallowed. Consequently, it remains to be seen how pervasive cognitive load effects are in a more naturalistic situation. In the subsequent sections I will discuss how specific (question) vs. unspecific (ambiguous interjection) feedback, and high vs. low levels of cognitive load might interact in affecting perspective-taking.

The Roles of Feedback Specificity and of Cognitive Load Fluctuations

Previous research has produced strong evidence for a general cognitive load effect on perspective-taking, but has not taken into account the role of feedback from the addressee. The basic question addressed in this paper is whether a cognitive load effect will be found even when feedback is available. An answer to that question will have to start from a distinction of two basic feedback types: *specific* and *unspecific*. Imagine a speaker facing a simple "uhuh" as an example of unspecific feedback from his or her addressee. It might signify understanding as well as surprise (Fussell & Krauss, 1992), will require the speaker to interrupt the ongoing message production, and interpret the precise meaning of feedback in order to adjust utterances. It is easy to see that this relatively complex adjustment step might be skipped under conditions of high cognitive load. On the other hand, questions as an instance of specific feedback will provide speakers with a more or less precise hint of how to correct incommunicative utterances. In this case, the adjustment is considerably easier than with unspecific feedback, so that perspective-taking might occur even under cognitive load.

The picture would be incomplete, however, if cognitive load were treated as remaining constant throughout speech production. More appropriately, cognitive load may be seen as a blend of sustained attention and acute attention peaks (see Gopher, 1994). Sustained attention is required because speakers "need to devote a great deal of attention to the … structuring of … [their] own behavior" (Osborne & Gilbert, 1992, p. 220), and speech planning is a part of that behavior structuring.

Peak loads arise during the transformation of a speaker's knowledge into a verbal message. This knowledge is represented both in propositional and nonpropositional (e.g. spatial) formats (see Freksa & Barkowsky, 1999). Whilst propositional knowledge is readily verbalizable – i.e., it might be directly translated into an utterance plan (see Levelt, 1989) – nonpropositional knowledge needs to be re-coded first (see Jackendoff, 1996). The amount of cognitive load induced by re-coding depends on the complexity of the knowledge structures to be re-coded. The latter can be conceived of as hierarchical scripts with scene headers. Headers contain subordinate knowledge units about the events of a scene (see Abbott, Black, & Smith, 1985).

Simple scenes might be referred to by their headers, requiring little or no transformation, because headers are verbal labels and thus contain knowledge in propositional format. More complex scenes with several events, however, will elicit more extensive transformations – and increase cognitive load – because the subordinate units might come in nonpropositional format. Thus, the attentional requirements of transformation will depend on the number of events in a scene.

In sum, it appears that cognitive load fluctuates considerably and systematically during speech production. If feedback modifies the cognitive load effect, that modification will depend on the amount of load at the time feedback is given. It will also depend on the type of feedback. The interaction of these factors was tested in the present research. It was hypothesized that speakers will respond differently to questions and interjections under low load, but will produce responses that do not differ as a function of feedback specificity when load is high. Two experiments tested these predictions with an instruction-giving task. Participants instructed their addressees how to assemble a small machine model. Experiment 1 explored fluctuations in cognitive load as a function of the complexity of assembly. In Experiment 2 participants received specific and unspecific feedback in moments of high and low cognitive load.

Experiment 1

In the first experiment the complexity of the assembly steps of a machine model was manipulated to test if complexity covaries with cognitive load. Participants carried out a quasi-continuous task while giving an instruction on the assembly of the machine model. It was expected that for complex steps, response latencies in the secondary task would be longer and error rates higher than for simple steps.

Method

Participants

Forty undergraduate students from different majors of the Freie University Berlin participated in the first experiment. They were paid € 10. All participants were native German speakers.

Materials

Participants gave an instruction on the assembly of a machine model from a Fischertechnik® construction kit. The model was approximately 12 cm tall, 8 cm wide and 20 cm deep. It had to be assembled from fourteen components that defined fourteen assembly steps. Each of the components either had to be assembled from two elementary pieces or consisted of only one piece. Assembly steps with two-piece components were defined as "complex," and assembly steps with single-piece components were "simple". For complex steps, the model had to be turned by at least 90° in order to complete the step. This sought to induce induced mental rotation during recall of the assembly. The complexity manipulation was modeled on the aforementioned notion of scenes consisting of single events. Each assembly step was considered to be a scene, and assembling (and rotating) the elementary parts were conceived of as the events of that scene. The assembly steps 1, 4, 5, 8, 10, 12, and 14 were complex; steps 2, 3, 6, 7, 9, 11, and 13 were simple. All components and their elementary parts were designated with pseudotechnical terms.

While giving their instruction, participants carried out a secondary task. The screen of a computer monitor was divided in two equal sectors by a vertical line. A yellow circle appeared in the center of one of the sectors, and one of the keys on a two-key response box had to be pressed if the circle appeared in the same sector on consecutive trials. The other key had to be pressed if the circle appeared in different sectors on consecutive trials. The assignment of keys to the same-sector and different-sector criteria was balanced across participants. Each circle remained visible for one second or until the response key was pressed. The interval between two circles was determined at random, but was no shorter than two seconds and no longer than four seconds. The maximum number of consecutive same-sector trials was five. Response latencies and error rates were recorded. Responses faster than 150 ms were excluded from the analysis as anticipations. Latencies slower than 1000 ms were recorded as errors. Participants were warned by a signal tone if they had made more than five errors in succession. Speech recording and measurement of secondary-task performance were synchronized by means of a 50 ms-tone. While the participants' utterances were being recorded on channel one of a digital tape recorder, a tone – that could not be heard by participants – was sent to the second channel each time a circle appeared on the screen.

In a pilot study, twenty participants accomplished this secondary task while carrying memory loads of different lengths that were adopted from Mulligan (1998). The loads were composed of either three, five, or seven items selected from a set of digits (1–9), and a set of letters (B, C, D, F, G, H, J, K, L). Each load started with a digit, digits and letters appeared in alternating positions, and no repetition of letters and digits was allowed in order to minimize chunking of loads. Participants were given forty-eight loads (sixteen of each length) in random order, with the constraint that no more than two loads of the same length were given in succession. Participants were asked to memorize the loads until given a recall signal, and to simultaneously perform the circle task. Repeated-measurement analyses of covariance (ANCOVA) with load length (three, five, or seven items) as factor and the mean response latencies and error rates from thirty base-line trials as covariates revealed that both mean response latencies, $F(1, 19) = 9.94$, $p < .01$, and error rates, $F(1, 19) =$

10.81, $p < .01$, increased with load length. No difference was found between the first and the last eight loads of each length, $F(1, 19) = 1.43$ and 1.12 for response latencies and error rates, respectively. In sum, the secondary task appeared to be sensitive to differing degrees of cognitive load, but was not susceptible to practice effects.

Procedure

The experiment had two main phases. In Phase 1, participants learnt the assembly of the machine model. They gave an instruction on the assembly in Phase 2.

At the beginning of Phase 1, participants were told that the experiment would investigate the cognitive processes underlying the production of verbal instructions. They would have to learn how to assemble a machine model and then verbally explain the assembly. The experimenter demonstrated and explained the assembly repeatedly, referring to each component with its technical term until participants signaled they had understood the assembly. They were then asked to practice the assembly until they felt sure they could explain it to someone else. After finishing practice, it was tested whether participants had learnt the technical names of the model parts. The experimenter presented the parts in a random sequence asking their technical names. The test was completed if participants could name each part correctly and immediately in two differently sequenced trials. This was to exclude the possibility that nontechnical references to model parts in the instructions to be given were due to the nonretrieval of names.

Participants were then invited into an adjacent room, and introduced to the addressee of their instruction (a confederate of the experimenter). Participant and addressee were seated at a table opposite to each other. A blind attached to the table precluded visual contact and had participants give purely verbal instructions. Participants were told that they would have to perform an additional task while giving their instructions. They were explained the secondary task and were informed that their response latencies and error rates would be recorded. They were also told that they should give priority to explaining the assembly, but should not neglect the secondary task. Because the experiment would be about "the strategies that people use when producing complex messages," participants were informed that "after you have given your instruction, I will play to you the recording, and I will ask you to explain why you formulated certain passages in the way you did". Next, participants were given thirty practice trials, and ninety base-line trials of the secondary task. After finishing the base-line trials, participants started giving their instruction. The addressee did not provide feedback, and participants were asked to give their instructions as monologues.

Variables

Participants' instructions were tape-recorded and transcribed verbatim. Two independent raters assessed both the naming of parts and the level of detailing for each assembly step. The inter-rater reliabilities were .92 for the naming and 0.86 for the level of detailing, as indicated by Cohen's κ. The following naming categories were used (examples from participants' instructions are given in parentheses):

Technical term: Participants referred to a model part with its technical term (e.g., "transmission unit," "pump holder"), no further specification (e.g., color or size) was given.

Description: Instead of employing the technical term, participants described a part in terms of its color, size or shape ("There's a piece with a tube, it's about two centimeters long, it has a lever at one side" = description of pump cylinder).

The level of detailing was assessed by the following categories (examples in parentheses):

Attachment specification: The point of attachment of two pieces to be assembled was mentioned ("Attach the crank to the transmission unit, you must insert it in the central hole in the unit's vertical strut").

Completion specification: The position of two pieces relative to each other after completing a step were specified ("The pump cylinder is in the correct position if its green end points to the gearwheel of the transmission unit").

Full specification: Both point of attachment and position of pieces were specified by participants ("Push the crank's rod into the middle opening of the vertical strut at the transmission device. The crankshaft must point to the holder").

Nonspecification: Neither attachment nor completion specification were provided. Instead, participants simply named two pieces to be put together ("You first fix the transmission unit at the base").

As a measure of perspective-taking, an index expressing the level of detailing was calculated separately for each assembly step. It was based on the earlier finding that speakers under high cognitive load produced "default" instructions: They referred to model pieces mainly with the technical terms, gave almost no additional descriptions, and in most cases instructed assembly steps without attachment or completion specification (Roßnagel, 2000). Utterances in the present experiment were evaluated with respect to this default. One point was assigned if an utterance had been coded in the description category. Two points were assigned if both the description and technical term categories applied. An additional point was scored if attachment and completion, respectively, were specified. For complex steps, the index was the average of the single indices of utterances referring to the elementary pieces of a component. In sum, four points were assigned to maximally detailed assembly steps (two points for naming, two for specification), whereas default utterances scored zero points.

Cognitive load during a given assembly step was assessed by computing the mean latencies and error rates from all secondary-task responses that fell within utterances referring to that assembly step. Compared to simple steps, it was expected that load would be increased for complex assembly steps. Also, a lower level of detailing was expected for complex steps.

Results and Discussion

For the analysis of the level of detailing, the detailing indices were averaged across simple and complex steps, respectively, and compared by means of repeated-measurements ANOVA with complexity as factor. For the cognitive load data, the mean response latencies and error rates were computed for simple and complex steps, respectively. These data were submitted to repeated-measurements ANCOVAs with complexity as factor and the mean latencies and error rates from ninety base-line trials as covariates.

The central finding was that of a significant effect of complexity on the level of detailing, $F(1, 39) = 10.03$, $p < .01$: simple steps were instructed in more detail than complex steps. Additional ANOVAs showed that there were no significant differences among the simple steps, $F(1, 39) = 1.04$, ns, nor the complex steps, $F(1, 39) < 1$, ns Latencies were faster for simple steps than for complex steps, $F(1, 39) = 9.03$, $p < .01$. Table 1 gives an overview of the level of detailing and the response latencies with each of the seven simple and complex steps, respectively.

Moreover, fewer errors were made with simple steps (5.2%) than with complex ones (9.8%), $F(1, 39) = 11.76$, $p < .01$. Significant differences were found both among the simple steps, $F(1, 39) = 4.32$, $p < .05$, and the complex ones, $F(1, 39) = 5.11$, $p < .05$. This difference resulted from a general practice effect. Shorter latencies and fewer errors were found for the last two steps of each complexity level, $F(1, 39) = 8.01$, $p < .01$ (simple steps), and $F(1, 39) = 9.77$, $p < .01$ (complex steps). Figure 1 shows the relationship between the mean level of detailing for simple and complex steps, respectively, and response latencies in the secondary task.

The first experiment started from the assumption that the cognitive load from giving an instruction will fluctuate systematically. It was hypothesized that load would be increased for complex assembly steps. These comprised more elementary operations than simple steps. As a consequence of increased load, a decrease in the level of detailing was expected for complex steps. Fluctuations of load were assessed by means of a secondary task that allowed for quasi-continuous measurement.

Results provided unequivocal support for the hypotheses offered. Both response latencies and error rates in the secondary task indicated that describing complex assembly steps required more cognitive capacity than did speaking about simple steps. At the same time, the level of detailing was significantly decreased for complex steps. Speakers relied on the technical terms in naming the pieces of the machine model because recalling these well-learnt names was easier than generating a description. Moreover, complex steps were almost exclusively described in a nonspecified manner. It appears that using technical terms and describing assembly steps at low levels of detailing reflects the operation of relatively auto-

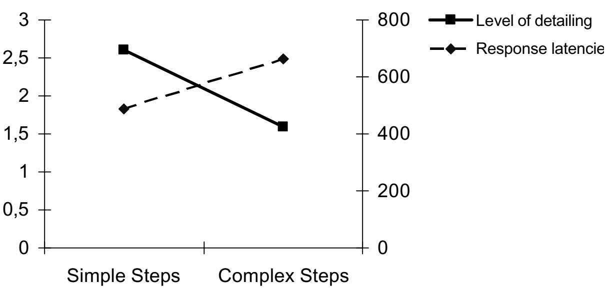

Figure 1. Mean level of detailing and mean response times in the secondary task for the single and complex assembly steps.

Table 1. Mean Levels of Detailing and Mean Response Latencies in the Secondary Task for Each of Seven Complex and Simple Steps, Respectively, in Experiment 1

	Complex steps							Simple steps						
Detailing	1.9	1.5	1.8	1.3	1.8	1.5	1.3	2.6	2.6	2.4	2.8	2.5	2.8	2.6
Latency	708	606	683	650	620	672	695	475	512	470	520	449	490	510

matic components of utterance planning. Apparently, the scene headers in the form of the names of the assembly steps were recalled, which served to avoid an increase in cognitive load. Because load was lower for simple steps, the additional effort of monitoring and correcting utterances could be taken. Technical terms and unspecified descriptions were identified as probably being uncommunicative to the addressee and were thus supplemented or substituted. This finding is in line with previous evidence (Roßnagel, 2000) of a trade-off between cognitive load and the level of detailing of utterances. As would be predicted by the monitoring and adjustment model, the incorporation of information in the utterance plan was dictated by the ease of retrieval rather than the listener's information needs. In sum, the manipulation of complexity appeared as an effective means of inducing different degrees of cognitive load. The communication task from the first experiment thus provided an appropriate starting point for investigating the interaction of cognitive load and feedback in the second experiment.

Experiment 2

The goal of the second experiment was to investigate how cognitive load affects the processing of feedback from the addressee. Questions ("How do I have to ...?") and an ambiguous interjection ("Uhuh!?") were employed as specific and unspecific feedback, respectively. Both types of feedback were given both during simple and complex assembly steps. Feedback effects were assessed by classifying speakers' responses into *expansions* (speaker provided additional information), *queries* (speaker asked addressee about reasons for nonunderstanding) and *repetitions* (speaker repeated initial utterance without expanding it).

Expansions and queries were expected to be the preferred response types with questions and interjections, respectively, during simple steps. During complex steps, repetitions were expected to be the most frequent response to feedback.

Method

Participants

Ninety-six undergraduate students from different majors of the Freie Universität Berlin took part in the second experiment. They were paid € 7.50. All participants were native speakers of German. None had taken part in the first experiment. Data from one participant were lost due to technical problems during recording and were replaced by data from another participant.

Materials

The machine model and secondary task from Experiment 1 were used in Experiment 2.

Procedure

The procedure of Experiment 2 was identical to that of the first experiment with the exception that the addressee provided feedback. Like in Experiment 1, participants practiced the assembly of the machine model in the first phase. In phase 2, they gave an instruction on the assembly, and received both specific and unspecific feedback from the addressee (a confederate of the experimenter). The specific feedback was a question that requested the speaker to increase the level of detailing ("How do I have to ...?"). The unspecific feedback was an interjection ("Uhuh!?) that could be taken to signify both understanding and doubt or surprise. Each speaker received both types of feedback both during simple and complex steps according to the following restrictions. Feedback was never given during the first and the last assembly step, and a step with feedback was followed by at least two steps without feedback. Feedback was always provided during the description of an assembly step. However, the confederate did not interrupt the speaker, but only gave feedback after the speaker had finished a given utterance. Specific feedback was always composed of the phrase "How do I have to ...?" and a reference to the speaker's previous description of an assembly step (see examples in the Variables section). The sequence of specific and unspecific feedback was balanced across speakers with the restriction that feedback of the same type was never given in succession. This yielded two sequences with, in order, specific and unspecific (SUSU), and unspecific and specific feedback (USUS) in turns. In order to avoid erroneous interpretations of responses to feedback, the recorded instructions were played to participants, and they were interviewed about their responses. They were asked to give reasons why they had responded in a particular way, and whether they thought they could have responded differently in order to secure the addressee's comprehension.

Variables

Speakers' responses to feedback were coded in four categories. For the analysis, the percentage of responses in each category was computed for each of the four combinations of feedback type and feedback position. The categories were:

Expansion: The speaker increased the level of detailing in response to the addressee's feedback ("Turn the lever towards the pump cylinder" – "How do I have to turn the lever?" – "You must turn it clockwise until its end points to the green end of the pump." = action description supplemented by completion specification).

Repetition: The speaker responded by repeating the initial utterance without substantially rephrasing it or providing additional information ("Now, you've got to turn the lever in the direction of the pump cylinder" – "Uhuh!?" – "Yes, simply turn it in the direction of the cylinder")

Query: Instead of repeating or expanding an initial utterance, the speaker enquired of the addressee the sources of his or her nonunderstanding. ("Fix the crankshaft at the vertical strut" – "How do I have to fix the crankshaft?" – "Uhm, you'd like to know where to fix it?"). In principle, specific queries ("I understand you want to know whether ...") and unspecific queries ("What's the problem?") could be distinguished. Yet, because only 6% of all queries were of the latter type, the data were collapsed across both types. The confederate's responses to queries aimed at minimizing any ensuing dialogue. In responses to unspecific queries, the confederate requested attachment specifications, and specific queries were answered with "Yes".

No response: A residual category that was used if the speaker did neither repeat nor expand the utterance before feedback was given, nor got back to the addressee in any other discernible way.

Results and Discussion

The percentage of responses in three of the four response categories (expansion, query, repetition) were submitted to a 2 × 2 MANOVA with feedback type (question vs. interjection) and cognitive load (low load = feedback during simple steps vs. high load = feedback during complex steps) as factors and repeated measurements on these factors. The no response category was excluded from the analysis because there were too few occurrences for a meaningful analysis: only in seven cases were interjections during complex steps not responded to. This finding will be discussed below.

Most importantly, the MANOVA yielded a significant interaction effect of feedback type and cognitive load, $F(3, 93) = 9.18$, $p < .01$, together with main effects of feedback type, $F(3, 93) = 10.26$, $p < .01$, and cognitive load, $F(3, 93) = 12.43$, $p < .01$.

Scheffé tests revealed that under low load, speakers' responses were a function of feedback type. In response to questions, speakers significantly ($F(1, 88) = 8.11$, $p < .01$) more often expanded their description (45.2% of responses) than using queries (25.3%) or repetitions (29.5%). With interjections, however, queries were used significantly ($F(1, 88) = 10.03$, $p < .01$) more often (52%) than expansions (29%) and repetitions (19%). Figure 2a displays the percentage of expansions, queries, and repetitions as a function of feedback type under low cognitive load.

Under high load, however, responses were a function of cognitive load, rather than of feedback type. The response frequency patterns were almost the same for questions and interjections. Expansions were employed significantly less often as a way of responding both with questions (28%; $F(1, 88) = 8.43$, $p < .01$) and with interjections (17%; $F(1, 88) = 9.39$, $p < .01$). Repetitions, on the other hand, were the predominant response with both questions (42%) and interjections (45%), whilst queries ranked between both response types (29.8% and 31% with questions and interjections, respectively. Figure 2b displays the percentage of expansions, queries, and

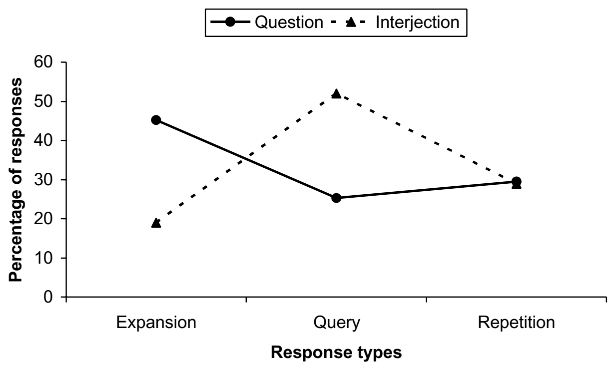

Figure 2a. Percentage of response types as a function of feedback type under low cognitive load.

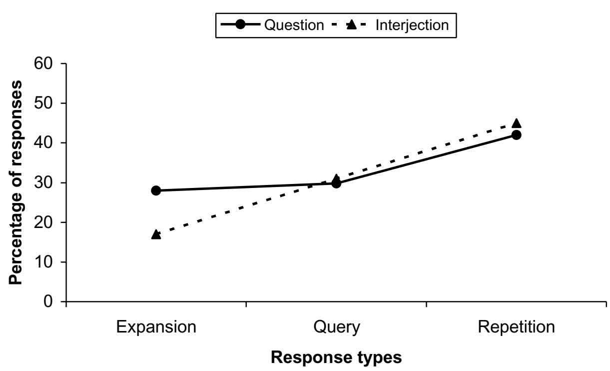

Figure 2b. Percentage of response types as a function of feedback type under high cognitive load.

repetitions as a function of feedback type under high cognitive load.

The second experiment investigated the effects of addressees' feedback on speakers' perspective-taking. Distinct feedback effects were found. Almost half of the speakers responded by expanding their previous utterances in response to questions as specific feedback when cognitive load was low. In the post-experimental interviews, speakers confirmed that they had done so in order to secure the addressee's comprehension. A considerable proportion of responses (26%) were queries, with the intention "to get a clue of how to make myself clear," as indicated in the interviews. On the other hand, almost a third of replies were simple repetitions of utterances in response to feedback. However, most speakers (28 out of the 30 concerned) said they had thought they had "had spoken too fast" or the "assembly step had been too complex to be understood right away".

This response pattern changed when cognitive load was high. Repetitions (43%) were the predominant response (expansions 28%). Given that in terms of speech monitoring, repeating an utterance is less demanding than rephrasing it, it appears that speakers compensated for the increased load from complex steps by using the repetition strategy. This reasoning is supported by an ANOVA on the average response latencies in the secondary task during repetitions and expansions, respectively, in response to questions during complex steps. Speakers responded significantly faster when repeating an utterance (629 ms) than when expanding it (785 ms), $F(1, 69) = 9.32$, $p < .01$. Data from the interviews fit with this picture. The majority (34 out of 41) of speakers who had responded with a repetition stated in the interviews they "felt the assembly step was very complicated".

A different picture emerges for interjections. When the confederate uttered an ambiguous "Uhuh!?" during a simple step, most speakers responded with a query. The number of repetitions was comparable to that in response to questions during simple steps, and speakers said in the interviews they had repeated their utterance in order to confirm it. In fact, 87% of the repetitions started with affirmative words or interjections like "Yes, …," "Right, …" or "Correct, …". In response to interjections during complex steps, however, the percentage of queries significantly decreased, and repetitions became the dominant response. Expansions played a minor role, and the percentage of this response type did not vary as a function of cognitive load. Like with the questions, the cognitively less demanding response of repeating an utterance was preferred over expanding it, and this might be taken as a way of dealing with increased cognitive load.

In sum, it appears that cognitive load substantially influenced processing of the addressee's feedback. During simple assembly steps that induced relatively low cognitive load, speakers appeared to be attuned to the addressee's feedback. During complex assembly steps, however, i.e., under conditions of relatively high cognitive load, simple repetitions of previous utterances became the dominant response type both for questions and interjections. The secondary task data suggest that repetitions were preferred over other types of response because they were cognitively less demanding. Finally, in seven cases, the addressees' feedback was completely ignored. Speakers later said they had not even heard the addressee, and this might be taken to indicate that so much of the speakers' cognitive capacity was usurped that they failed to adequately attend to the addressee.

General Discussion

The aim of this paper was to extend the analysis of cognitive load effects on perspective-taking in verbal communication. Previous research had shown cognitive load to negatively affect perspective-taking, but it remained to be seen whether the effect would generalize to more naturalistic situations including feedback from the addressee. In sum, the results from two experiments draw a clearer picture of the cognitive-load effect in terms of external validity. Cognitive load to date had been treated as an all-or-none factor in the context of perspective-taking. Fluctuations of load and correlated changes in perspective taking had not been taken into account. Results from this research could have left one with the impression that speakers' cognitive capacity was so limited that they would stop taking their addressee's perspective no sooner than speaking became a bit more difficult than usual. It is obvious that this would be too simple a notion, and the present results put the cognitive load account in perspective.

The effects of the complexity manipulation in the first experiment demonstrated that neither perspective-taking nor its reduction as a result of cognitive load are all-or-none processes of message production. Speakers adapted to their addressees in one sentence, and abandoned adaptation in the next, if two assembly steps differed in their complexity and thus the amount of information to recall. This finding clearly supports the monitoring and adjustment model of perspective-taking of Horton and Keysar (1996).

As an alternative to the monitoring model, Polichak and Gerrig (1998) advocated the *initial design* model: perspective-taking is seen as a one-step process inasmuch as common ground is integral to speech-planning. Consequently, there is no utterance *without* perspective-taking. In their critique, Polichak and Gerrig contended that Horton and Keysar offered no rigorous arguments to support their assumptions, because errors under time pressure did not necessarily reveal speakers' original plans. In fact, time pressure might discomfit planning or monitoring, or both. The critique of Polichak and Gerrig obviously does not apply to the present research. Cognitive load was not induced by external constraints, such as time pressure or a demanding secondary task. It rather followed from inherent properties of the model assembly.

The second experiment demonstrated that the cognitive load effect is large enough to affect perspective-taking even in a quasi-dialogical situation. Speakers responded differentially to the addressees' questions and interjections in moments of relatively low load. High load, on the other hand, produced rather uniform responses that did not differ as a function of feedback specificity. Under high load, speakers apparently skipped the adjustment stage of perspective-taking. Whilst previous experiments may be criticized of not having taken the social nature of speaking into account, the present experiment provided evidence of an interaction of cognitive and social factors. The addressees' feedback modified the speakers' utterance planning under low load, but had a much smaller impact when load was high. Research on the role of cognitive load in communication might thus contribute to second-generation theories of communication that accommodate both cognitive and social influences on message production (see Greene, 1997; McPhee, 1995). The present study is of course far from being a full-fledged analysis of the interaction of social and cognitive factors. Future research will have to explore, for instance, the roles of speakers' and listeners' expertise in a given domain, and the quality of their relation (e.g., with regard to status differences). Such aspects will naturally come into play if perspective-taking research is extended to applied fields. For example, in their investigation of dialogues of medical assistance telephonists, Marchand and Navarro (1995) found important differences when the telephonist conversed with specialists than when nonspecialists were addressed. When callers were private individuals, the situation was an indefinite problem that required the telephonist to adapt to the caller in order to obtain relevant information as quickly as possible. To the extent that the complexity of callers' question varied, cognitive load might have varied accordingly and might have influenced both processing of the questions and the quality of the answers.

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