IS THERE ANY DIFFERENCE BETWEEN CONVERSING BY PHONE AND CONVERSING WITH A PASSENGER WHILE DRIVING?

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ABSTRACT

The aim of this study was to better understand how may differ conversing by phone and conversing with a passenger by comparing the driver's speech in both conditions. Sixteen drivers (from 21 to 50 years old) participated in an on-road experiment on motorway. Naturalistic conversations were performed in 3 conditions: car stationary, while driving under Low or High attentional demand. Speech indicators such as speech rate in words per minute, number of hesitations and repetitions per word were investigated.

Phoning was revealed as being more complex than conversing with a passenger as shown by a decrease in speech rate and an increased number of hesitations and repetitions. Results also showed the negative influence of the driving condition complexity on the speech quality.

KEYWORDS

Driving, Distraction, Phone, Passenger, Speech, On-road experiment

INTRODUCTION

Many researches conducted since the 1990s have shown the negative impact of cell-phone on the driving (Maccartt, Hellinga & Bratiman, 2006; Horrey & Wickens, 2006; Caird, Willness, Steel & Scialfa, 2008 for a review). Conversing while at the wheel requires additional mental resources from the driver, which interferes with the driving task. Speaking with a hands free phone instead of a hand-held one does not appear to reduce the interference with the driving task. It seems there is no significant difference between both phone modes, except considering the driving speed, which decreases in case of hand-held phone (Patten, Kircher, Östlund & Nilsson, 2004; Törnros & Bolling, 2005). In this framework, some authors have also compared the disturbing effects of listening to a radio broadcast or to a book tape with telephoning (Strayer & Johnston, 2001; Consiglio, Driscoll, Witte & Berg, 2003; Bruyas, Chapon, Lelekov-Boissard, Letisserand, Duraz & Aillerie, 2006). The results show that radio listening does not lead to significant distractive effects and reveal that all auditory tasks do not impair the driving performance in the same manner. For Strayer & Johnston (2001) and McCarley, Vais, Pringle, Kramer, Irwin & Strayer (2004) an active engagement is necessary to produce dual-task interference. Moreover, the interference level is modulated by the complexity of the secondary task (Patten et al., 2004). In parallel, some authors have also compared the effects on the driving of talking by phone and talking with a passenger. Findings are differing and the extent to which both tasks could induce the same interference still remains unclear.

One of the first researches, which compared the two tasks was realized by Fairclough, Ashby, Roos & Parkes (1991). For these authors conversing by phone resulted in an increase of the heartbeat rate as compared with talking to a passenger. Their first explanation was that the novelty of the phone use while driving could have generated an additional stress in their drivers who had none significant experience of phoning while driving. They also hypothesized that a car phone conversation could be more demanding than speaking to a passenger. Later, Consiglio et al. (2003) found a small, but non-significant, increase in the response times between conversations with a passenger and by phone. However, for these authors it would perhaps not be the same in real road driving, when drivers can adapt their flow according to the situations, which could be easier to realize with a passenger than by phone. The work by Drews, Pasupathi & Strayer (2008) confirmed this assumption and showed that a passenger and phone conversations differ because the surrounding traffic can become a topic of the conversation, which help passenger and driver to share the same situation awareness and consequently mitigate the negative effects of the conversation on the driving task. Crundall, Bains, Chapman & Underwood (2005) gave evidence to support this approach. Their results showed that in-car communications can be modified according to the demand on the road, which they called the Conversation Suppression Hypothesis. Driver and passenger naturally suppress a conversation during times of complex driving situations, which cannot occur with phone calls.

Concerning the driving task, Gugerty, Rakauskas & Brooks (2004) investigated the effect of conversations on the drivers' Situation Awareness. Their results showed that the processing of the driving-related information was degraded by all verbal interactions. No evidence of a greater degradation was highlighted when the driver's interlocutor was remote than when he/she was in the car. The authors underlined however that in case of being very involved in a phone conversation, drivers could be not able to shift attention away from this task to come back to the driving task. Divergent results were obtained by Drews et al. (2008) who evaluated different measures of driving performance reflecting operational, tactical and strategic processes. They observed a greater lane keeping variability, greater following-distance between the driven vehicle and vehicles ahead, and a navigation task being performed poorly in the phone condition as compared with the passenger condition.

Hunton & Rose (2005) found in a simulator experiment that phone conversations were associated with more driver errors and crashes than conversations with passengers. For these authors, phone conversations are more cognitively demanding and fewer resources are left available for the driving task. Such results are in accordance with Charlton's ones (2009), which showed a higher crash rate with drivers talking on a cell phone, as compared with talking to in-car passenger.

Objectives

The objective of the present work was to better understand the specificities of conversing by phone and conversing with a passenger by comparing the driver's speech in both conditions to explain their potential distinct effects on the driving task.

Contrarily to written language, spontaneous speech contains stops, false starts, repeated words, restarted ideas and also fillers or filled pauses such as "um" in English or "euh" in French (Bailey & Ferreira, 2003). Such items are known as disfluencies due to the fact they interrupts the flow of speech and do not add any content to an utterance. For instance, filled pauses are often used when a speaker needs more time to produce an utterance (Clark & Fox Tree, 2002). By warning the interlocutor of such a delay, they constitute a conventional way for the speaker to keep the floor and to avoid being stopped during the time he/she needs to end. It has also been showed that a greater number of fillers are used for producing answer speakers lack confidence in or before a non answer (Brennan & Williams, 1995). Disfluencies could then been considered as an expression of greater difficulties in the speech management. Beyond the disfluencies, other indicators can be used to analyse spontaneous discourse, such as its fluency, which gives information about the flow of the speech.

To attain our objective, an on-road experiment was conducted on motorway. Highly interactive communications were performed either by phone or with the passenger. It was hypothesised that a phone conversation will be of better quality than a passenger conversation. This better quality will be assessed first by the fluency of the speaker and then by the number of disfluencies. It was hypothesised also that the speech will be more degraded while driving as compared with vehicle stationary, and that the degradation will be even greater when the driving demand placed on the driver will increase.

METHOD

The following experiment was carried out under the conditions specified by the amended law of 20 December 1988 (the Huriet-Sérusclat protection of individuals act).

Participants

Sixteen drivers aged from 21 to 50 years old (8 women and 8 men, average age 31 years, SD=8.3) took part in this experiment. All of them declared having no visual or auditory deficiency. All of them had already used a mobile phone while driving, at least occasionally. All of them had their driving license for more than two years.

Procedure

On arrival, participants completed a questionnaire with personal data. They were then given written instructions explaining the experiment. The experiment began with a short training period of 10 to 15 minutes of driving to allow the drivers to become familiarized with the vehicle (INRETS-LESCOT experimental car, Citroen ZX) and also with the use of the hands-free phone.

Then the experimentation itself proceeded on motorway near Lyon. The participants were asked to drive as naturally as possible while respecting the Highway Code. The driven distance was about 50 kilometres. The experiment was run in midmorning or middle of afternoon in order to obtain equivalent traffic conditions between the participants by avoiding strong traffic in the entry of the city.

Conversation task

During the course, participants were asked to answer when the phone was ringing and also to discuss with the passenger when the latter started a conversation. Four conversations were carried out (mean duration of each 3 minutes and half) by each participant: two on the phone and two with the passenger. Both types of conversation were initiated by two female experimenters: one at the phone, in a following vehicle, and the other one as the passenger sat besides the driver. The experimenters were instructed to follow a discussion guide and to maintain the discussion, as defined in the guide whatever the traffic conditions were. The phone calls were carried out via a Nokia hand-free phone (wireless device equipped with a microphone and using the loudspeakers of the vehicle).

The objective was to evaluate conversations that were as naturalistic as possible. Four realistic fictitious situations for communication were therefore constructed in order to provoke highly interactive conversations. The same fictitious situations were applied alternately for the phone conversation and the conversation with a passenger. They related to aspects of the daily life: participants' culinary dietary habits and their preferences, choices for holidays and preferred transport modes, characteristics of their car and knowledge on the highway codes, audio and video home equipment and habits concerning watching the TV. In each case, a discussion guide was established to help the experimenter running the conversation. The order in which the topics were discussed, and the type of conversation (with passenger or by cell phone), were randomly determined for each participant. Half of the drivers started with a phone call while the other half started by conversing with the passenger. To leave the drivers pace the communication by themselves, both experimenters were asked to not take into account the traffic conditions, following the discussion guide all along the conversation, as would have done an inconsiderate passenger (Merat & Jamson, 2005).

At the end of the experiment, the same topics were continued while the vehicle was stationary. The drivers carried out one conversation by phone and one with the passenger (mean duration of each 2 minutes).

Data acquisition

Driving conditions coding

The car was equipped with four mini video cameras for capturing images from the road environment (front road scene and back road scene), the face of the driver and the dashboard of the vehicle. Images were gathered by a multiplexer and recorded by a video tape recorder located at the back of the car. Two types of road situations were distinguished and coded afterwards to evaluate the effect of the demands placed on the driver during the driving:

- Low demanding situations: when the participant drove straight away without changing lane or having the intention of doing it.
- High demanding situations: when the participant was overtaking a vehicle or had the intention of doing it. The latter condition was verified if the driver frequently checked the mirrors while following a vehicle.

Speech coding

A microphone fixed on the participant's chest allowed for the audio recording of the conversations. The total time of conversation analyzed for the 16 participants was of 4 hours and 47 minutes (3 hours and 39 minutes while driving and 1 hour and 8 minutes while the vehicle was stationary), including 2 hours 39 minutes during which the participants were speaking (2 hours and 6 minutes while driving and 33 minutes while the vehicle was stationary).

All audio-taped conversations were transcribed verbatim. Silences, repetitions and fillers were also written precisely. The typescripts were corrected for inaccuracies by listening as much as needed. The software TextStat 3.0 was used to compute the number of words, fillers and repetitions for each conversation.

Dependant variables

Four dependant variables were computed for each type of conversation.
The two first ones allowed us for evaluating the fluency or flow of the speech of each driver:

- *Speech rate including fillers*: number of words pronounced plus fillers per minute.
- *Speech rate*: number of words per minute.

The two other ones gave information on some aspects of the speech disfluency:

- *Filler rate*: number of hesitations (i.e. the number of "euh", "ffeu" …) per word pronounced.
- *Repetition rate*: number of times a word is repeated at least twice before a new one is pronounced divided by the total number of words.

Statistical procedure

The experimental design included two within-subjects factors:

- The conversation: conversation by phone (*Phone*) or with the passenger (*Passenger*)
- The driving condition: vehicle stationary (*Stationary*), low demanding driving situations (*Driving Low*) and high demanding driving situations (*Driving High*).

The assumption of normality (tested by Shapiro-Wilk Tests) was met for the two measurements of the *speech rate*. For *Fillers* and *Repetitions*, which appeared to be non-normally distributed, square root transformations were used to normalise the data.
Comparisons were made using repeated measure ANOVAs for each variable. In all cases, paired comparisons were then computed with the Fischer LSD (Least Significant Difference) test. A significance threshold of 0.05 was accepted ($p < 5\%$).
The statistical procedures were performed with SPSS.

RESULTS

Speech rate including fillers

A first measurement of the *speech rate including fillers* was computed taking into account the number of words plus the number of fillers per minute (Fig. 1). Repeated measures ANOVA did not show significant differences between the two types of conversation [$F(1, 15) = 2.680$, $p = 0.122$] but showed significant differences between the driving conditions [F(2,

14) = 28.071, $p < 0.001$]. Interaction between the two factors did not appear to be statistically significant [$F(2, 14) = 0.197$, $p = 0.823$]. Paired comparisons computed with the Fischer LSD showed that this first value of *speech rate* was significantly higher while the car was *Stationary* than in the 2 driving conditions, but no significant difference was found between the *Driving Low* condition and the *Driving High* condition.

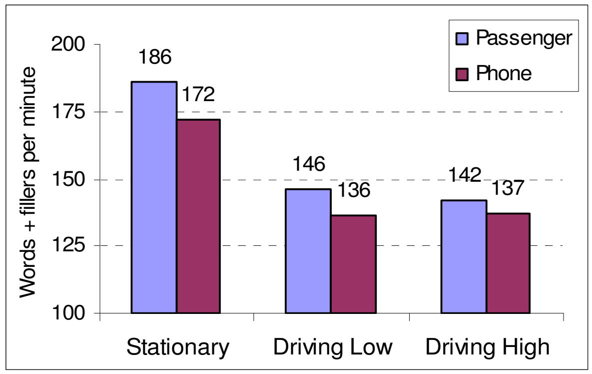

Fig. 1: Speech rate including fillers for the 2 conversations according to the driving conditions

Speech rate

A second measure of the *speech rate* was then computed only taking into account the number of words said per minute (Fig. 2). In that case, ANOVA analysis showed significant differences between the two types of conversation [$F(1, 15) = 5.676$, $p = 0.031$] and between the three driving conditions [$F(2, 14) = 40.551$, $p < 0.001$]. Interaction between the two factors did not appear to be statistically significant [$F(2, 14) = 0.502$, $p = 0.616$]. As expected, the speech rate was significantly higher for the conversation with the *Passenger* than for the *Phone* conversation. Paired comparisons computed with the Fischer LSD showed that it was significantly higher while the car was *Stationary* than in the 2 driving conditions and also that it was significantly higher in the *Driving Low* condition than in the *Driving High* condition.

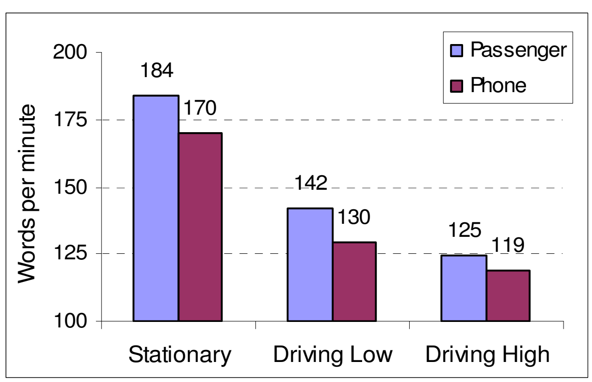

Fig. 2: Speech rate for the 2 conversations according to the driving conditions

Fillers

The number of hesitations or *fillers* per word was then computed (Fig. 3). The analysis yielded an effect of the type of conversation [$F(1, 15) = 20.596$, $p < 0.001$] and a global effect of the driving situation [$F(1, 14) = 16.489$, $p < 0.001$]. Interaction between the two factors did not appear to be statistically significant [$F(2, 14) = 0.175$, $p = 0.841$]. The mean ratio of fillers was significantly lower for the conversation with the *Passenger* than for the *Phone* conversation. Paired comparisons computed with the Fischer LSD showed that the mean ratio of fillers was significantly lower while the car was *Stationary* than in the 2 driving conditions and also that it was significantly lower in the *Driving Low* condition than in the *Driving High* condition.

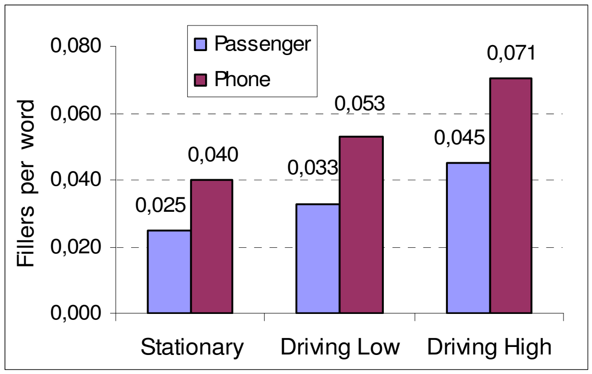

Fig. 3: Proportion of fillers for the 2 conversations according to the driving conditions

Repetitions

The number of *repetitions* per word was also computed (Fig. 4). The analysis yielded an effect of the type of conversation [$F(1, 15) = 7.080$, $p = 0.018$] and a global effect of the driving situation [$F(1, 14) = 4.400$, $p = 0.033$]. Interaction between the two factors did not appear to be statistically significant [$F(2, 14) = 0.377$, $p = 0.693$]. The mean ratio of repetitions was significantly lower for the conversation with the *Passenger* than for the *Phone* conversation. Paired comparisons computed with the Fischer LSD showed that the mean ratio of fillers was significantly lower while the car was *Stationary* than in the 2 driving conditions, but no significant difference was found between the *Driving Low* condition and the *Driving High* condition.

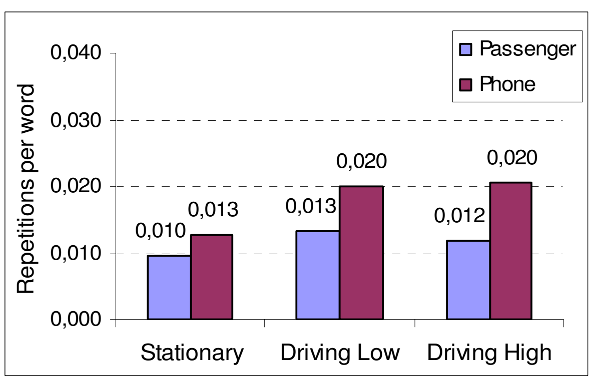

Fig. 4: Proportion of repetitions for the 2 conversations according to the driving conditions

DISCUSSION

The aim of the present experiment was to better understand how may differ a conversation by phone and a conversation with a passenger by comparing the drivers' speech in both

conditions. The results revealed important differences between the two types of communications. When talking by phone, the drivers maintained their speech delivery constant by using fillers as compared with talking with the passenger, but their speech rate in terms of words per minute decreased significantly. Such a result suggests a decrement in the speech quality of the phone conversation and expresses the drivers' difficulty to maintain the flow of the speech. This decrement is confirmed by the analysis of disfluencies. While phoning, the drivers used a higher number of fillers or filled pauses and also repeated words more often, than when talking to the passenger. These results are in accordance with Gugerty et al. (2004), who compared word games in both conditions. In their experiment, drivers and their interlocutors said alternatively a word that starts with the end letter of the word said by the counterpart. Drivers slowed their word production more, while at the phone, than in the passenger condition and also made more verbal errors. Comparable results were also obtained by Waugh, Glumm, Kilduff, Tauson, Smyth, Pillalamarri & Ramakrishna (2000).
The fact drivers slow their speech delivery and also make more language errors can be explained by the greater difficulty of performing a phone conversation than an in-car conversation. Fox and Parkes already suggested in 1989 that the most significant differences between phone and face to face conversations is the absence of social cues which increases the psychological distance (as cited by Fairclough et al, 1991) whereas the social presence reduces it. The work from Alibali, Heath & Myers (2001) gives some explanations to this phenomenon. These authors demonstrated that people speak more slowly and produce a higher rate of fillers when their interlocutor is not visible than in a face to face interaction. For these authors, the visibility between speaker and listener influences the speaker's production of gestures. Speakers decrease their production of gesture when their listener is not visible and compensate for this reduction by an increase in the filler rate. As emphasised by Hunton & Rose (2005), conversing by phone would then require significant additional cognitive resources from the drivers, who try to derive the nonverbal cues which would have been supplied in the case of a face to face conversation. This lack of non-verbal cues would require a huge amount of attention to try to deal with the missing cues, which render the conversation more demanding.
Another aspect was also underlined by Consiglio et al. (2003), which is the greater expectation of continuous conversation which characterizes a phone conversation. In the present experiment, drivers used a higher number of fillers and repeated words more often in the phone communications. Such a result could express the necessity to ensure continuity in the conversation. A silent being potentially misunderstood by their phone addressee, the need to occupy the ground of the interaction could have been more pronounced when talking by phone than when speaking to the passenger. In that case, fillers and repetitions could have also been used to keep on the line. However, such a process is effortful for the driver and more sustained attention is requested to maintain the conversation continuity.

The complexity of the driving task also appeared to have a negative impact on the speech quality. The drivers slowed their speech rate and increased the number of fillers and repetitions from the single (car stationary) to the dual task condition (while driving). As shown above, they also maintained their speech delivery constant by using fillers from the low to the high driving condition, but their speech rate in terms of words per minute decreased significantly, as the number of fillers pronounced significantly increased.
Previous work from Gugerty et al. (2004) suggested that since driver and passenger shared the same situation awareness, they could modulate their speech production to match changes in the complexity of the driving task. Crundall et al. (2005) went further and designed a driving task which varied the demand placed upon the driver to test what they called the suppression hypothesis. Their results showed that conversational suppression occurred when both driver

and passenger can see the road ahead. In such a case, the average length of the utterances is affected by the roadway: shorter utterances are given on more demanding roads.
Divergent results were obtained by Drews et al. (2008), who compared the driver speech production (measured in syllables per second) according to the demand of the driving task. Contrary to our results and also to Crundall et al. (2005) ones, they did not find evidence that drivers modulate their speech production to match changes in the complexity of the driving task. When the driving condition became more demanding, the production rate of the drivers decreased during in-car conversations but increased during phone conversations. Drews et al. (2008) explain this result by the active role played by the passenger in the in-car conversations, which ones include more turn-taking and more references to the driving situation, than in case of a phone call; and the fact that the driver can rely on he/her interlocutor to accommodate his/her speech production.
In the experiment described in this paper, the passenger was asked to keep the conversation pace constant, without considering the specificities of the road conditions when speaking. As well, the traffic conditions could not become a conversation topic as both phone and passenger speakers followed a discussion guide. Then, the driver was the only one who could regulate the conversation. In such a condition, neither the modulation nor the suppression hypothesis could be assessed.
However, our results show some similarities with the ones from Crundall et al. (2005), who observed a decrease in the number of utterances when the complexity of the driving demand increased. In the present experiment the decrease in speech production was only observed in terms of number of words per minute. When fillers were computed in the speech rate, no difference remained due to their higher number in the high demanding condition. This latter result can be linked with Drews et al. (2008) findings, which show that while conversing by phone, the driver would have felt the necessity to dominate the conversation. The increase in the filler rate that we registered may have also served a similar process. The drivers could have attempted to keep the control of the conversation to compensate for their difficulty to maintain the speech production when the driving demand increased. Moreover, Drews et al. (2008) also measured the complexity of the speech (in terms of number of syllables per word) and observed a decrease in this complexity in response to the demand of the driving task. Such a result is also in accordance with the increase in filler rate we registered, corresponding to a degradation of the richness of the speech. This could be seen as a way to mobilise the attentional resources differently or the expression of some trade-off effects. By doing so, the driver would have paid less attention to the communications (by phone and with the passenger) and privileged the driving task when the demand increased.

The present experiment might suggest that the attentional demand placed on the driver is greater when talking by phone than when conversing with a passenger, even when the passenger don't take into account the traffic condition. As suggested by Hunton & Rose (2005), phone communications consume more attention than passenger conversations leading to fewer resources remaining available for the driving task. On the contrary, processing a conversation with a passenger requires less attention and effort from the driver, which would allow more attention to spare for the primary driving task. As more complex verbal tasks induce higher decrement in the driving performance, talking by phone should then generate a greater interference with the driving.

Before ending, some limitations to this study must be highlighted. A first remark should be made on the passenger attitude, which could be determinant in the diversion of attention generated by the conversation. In this experiment, traffic-related modulations from the interlocutor were not investigated, which may have influenced the data. However, such situations are not so infrequent. Passengers in real life don't always share the driving awareness with the driver. A passenger who is too much engaged in the conversation or too young to understand the demand placed on the driver, such as a child, would certainly behave such as our speakers.

A second remark could be made concerning the variables we studied. Some other language descriptors could have also been used such as the measures of the richness of the semantic content of the speech: use of verbs, length of the utterances, and diversity of the lexica (number of different forms of words). An analysis of silence in driver speech would have also given some more explanations about the complexity of both communications. Further analyses of the speech should be done to investigate these aspects of the discourse.

By carrying out this experiment on real road, not using word games but naturalistic conversations, we aimed at evaluating natural situations to provide realistic measures of the two kinds of conversations. This may have rendered some comparisons more difficult to perform, but gave the richness of natural situations.

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