The Effect of Secondary Tasks on Perceived Seating Discomfort

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To investigate their effect on perceived seating discomfort, three different secondary tasks were investigated. Participants (N=45) had to rate their subjective overall discomfort feeling using the CP-50 scale directly after sitting down and from there on every five minutes for a duration of 50 minutes. Additionally, the overall discomfort for the whole experiment was rated after a five minute phase of movement. Concerning the secondary task, three groups (no secondary task; passive secondary task; active secondary task) were formed and each participant was randomly assigned to one group. No significant differences (p > 0.05) were found in the perceived discomfort of the three groups and in the recalled discomfort rating after the five minutes of movement of the different groups.

Practitioner Summary: Seating discomfort studies have been conducted frequently. But, the possible effect of additional tasks (e.g. none or driving) performed by the participants on discomfort ratings has not yet been investigated. The quality of discomfort studies might increase when secondary tasks are taken into account.

Keywords: Discomfort, Seating, Secondary Task

1. Introduction

Customers expect comfort requirements to be fulfilled nowadays (Kolich, 2008). Hertzberg (1958) claimed that comfort is the absence of discomfort but Zhang, Helander and Drury (1996) found, using a cluster analysis, that comfort and discomfort are two separate dimensions and not the opposite of each other. Comfort is highly associated with subjective feelings (Zhang et al., 1996; Knoll, 2007) and therefore not objectively measurable. Therefore, it is important to conduct discomfort studies in order to meet costumers’ needs.

The presented study is part of the project UDASim, funded by the German ministry of education and research, aiming to assess the global discomfort in vehicle passengers by simulating outcomes using three digital human models AnyBody, CASIMIR and RAMSIS (Ulherr & Bengler, 2014). These outcomes are supposed to be the input of an artificial neural network to predict the global discomfort. The artificial neural network will be trained and validated using experiments with human subjects. Therefore, subjects will rate their discomfort for several different conditions. For the experimental design, especially the duration and side task during discomfort studies, a literature review was conducted.

Various studies have objectively measured discomfort (or comfort) (Grandjean, Jenni & Rhiner, 1960; Corlett & Bishop, 1976; Gyi & Porter, 1999; Ebe & Griffin, 2000; Inagaki, Taguchi, Yasuda & Izuka, 2000; Kolich & Taboun, 2004; Mergl, 2006; Hartung, 2006; Wang, 2008; Kyung & Nussbaum, 2013; Le, Rose, Knapik & Marras, 2014). The test designs of these aforementioned studies varies quite a bit. There is no standard procedure in designing discomfort studies. Furthermore, no researching findings have been presented that describe the influence of a possible secondary task during seating discomfort studies.

2. Methods

2.1. Approach

To improve the quality of discomfort studies and their results, two research questions were formulated:

- How do different secondary tasks during discomfort seating studies affect the discomfort rating of the participants?
- Does the secondary task have an effect on the evaluation of seating discomfort?
The second question is inspired by the work of Redelmeier and Kahneman (1996), who found out that the memory of a painful medical procedure highly depends on the pain at the worst and final parts. We tested two hypotheses:

1. The perceived discomfort varies according to the conducted secondary task.
2. The recalled discomfort varies according to the conducted secondary task.

More precisely, we expected the discomfort in both cases to be lower while conducting an active secondary task compared to a passive secondary task. And again to be lower while conducting a passive secondary task compared to no secondary task:

\[ \text{Discomfort}_{\text{active secondary task}} < \text{Discomfort}_{\text{passive secondary task}} < \text{Discomfort}_{\text{no secondary task}} \]

Since a definition or categorization of secondary tasks during seating discomfort experiments was not found in the literature, the experimenters of this study implemented their own secondary task conditions.

### 2.2. Overview experiment and participants

The study was conducted at the Institute of Ergonomics, Technische Universität München. Previous research indicated that the discomfort ratings of males and females are significantly different (Gyi & Porter, 1999; Hartung, 2006). Furthermore, Hatta, Ueno and Nagashima (1987; as cited by Yamazaki, 1992) claimed “that the male, young, and slender subjects show a better coefficient of agreement in their distinction by feeling than the female, old, and fat subjects”. To reduce possible effects of gender, age and anthropometric measurements, only male participants between the ages of 20-35 years old and within the 40th and the 60th percentile of body height (178.80 cm – 183.10 cm) were tested. Forty-five males (Age: \( M = 24.51, \ SD = 3.14 \); height: \( M = 181.48 \text{ cm}, \ SD = 3.33 \)) participated.

A between subject design was used in the study. Three secondary task conditions were tested, and randomly assigned to each participant:

1. No secondary task
2. Passive secondary task
3. Active secondary task

The group without a secondary task sat for the duration of the experiment without any specified distraction. For those with a passive secondary task, these test persons watched a winter sports documentary, which was used to focus the attention of the participants but not necessarily distract them. The active secondary task was to play the videogame “Mario Cart” on a Nintendo 64™ game console, which was used to completely occupy the attention of the participants.

An aircraft seat was chosen for this seating discomfort study to provide the same condition for every participant without the possibility to adjust the seat. The seating position of an aircraft seat also seemed more adequate for watching a movie and playing a videogame. The seat in combination with the screen for the videogame and the movie is shown in Figure 1.

![Figure 1. Used aircraft seat (grey) in combination with the screen used for the video game and the movie.](image-url)
the participant rated his overall discomfort using the CP-50 scale (Shen & Parsons, 1997). Every five minutes, participants rated their discomfort level relative to the first rating. After 50 minutes, the participants were told to walk around for five minutes and then to provide a rating for the discomfort they felt while previously sitting (recalled overall discomfort rating). Every subject (number of participant: j) rated the perceived overall discomfort 12 times during the session ($D_{ij} ... D_{11j}$), 11 times sitting while conducting a secondary task ($D_{ij} ... D_{10j}$) and one time the recalled perceived overall discomfort ($D_{11j}$).

The duration of 50 minutes and the rating every five minutes was selected to research the effect of the sitting duration on the perceived seating discomfort, which results are not presented here.

The performed secondary task is the independent variable and the perceived discomfort the dependent variable in this research.

3. Data Analysis and Results

The data were analyzed using the software IBM SPSS Statistics 22.

3.1.1. Effect of the secondary task on the overall discomfort rating

The effects of time and secondary task are expected to be independent. So, the mean overall discomfort ratings ($D_j$) over the time for every participant (number of participant: $j$) were calculated as $D_j = \frac{\sum_{i=1}^{n} D_{ij}}{n}$, with $n = 11$ (number of perceived overall discomfort ratings per participant) and $j = (1, 2, ... 45)$.

The mean discomfort ratings are used to conduct an independent one-way ANOVA test. The dependent variable is the mean discomfort ratings and the independent variable (factor) is the secondary task. Table 1 shows the results of the ANOVA.

<table>
<thead>
<tr>
<th>ANOVA</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>39.122</td>
<td>2</td>
<td>19.561</td>
<td>0.413</td>
<td>0.664</td>
</tr>
<tr>
<td>Within Groups</td>
<td>1989.093</td>
<td>42</td>
<td>47.359</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2028.215</td>
<td>44</td>
<td></td>
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</table>

There was no significant ($\alpha = .05$) effect of the secondary task condition on the perceived overall discomfort rating ($F(2, 42) = .413, p = .664, \omega = .92$), indicating that the choice of secondary tasks for discomfort studies does not affect the perceived discomfort ratings of the participants. Therefore the first hypothesis (1) in Section 2.1. needs to be rejected.

3.1.2. Effect of the secondary task on the recalled discomfort rating

The recalled discomfort ratings ($D_{11j}$, with $j = \{1, 2, ... 45\}$ (number of participant)) were used to conduct an independent one-way ANOVA test. The dependent variable is the recalled overall discomfort ratings and the independent variable (factor) is the secondary task. Table 2 shows the results of the ANOVA.

<table>
<thead>
<tr>
<th>ANOVA</th>
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<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
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<tbody>
<tr>
<td>Between Groups</td>
<td>35.378</td>
<td>2</td>
<td>17.689</td>
<td>0.313</td>
<td>0.733</td>
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<td>Within Groups</td>
<td>2370.533</td>
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<td>56.441</td>
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<td>Total</td>
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</tbody>
</table>

The conducted ANOVA shows no significant ($\alpha = .05$) effect of the secondary task condition on the recalled discomfort rating ($F(2, 42) = .313, p = 0.733, \omega = .88$), indicating that the choice of secondary tasks
for discomfort studies does not affect the recalled discomfort ratings of the participants. Therefore the second hypothesis (2) in Section 2.1. needs to be rejected.

4. Discussion
Overall, the findings of the conducted study suggest that there may not be an effect of secondary task conducted during discomfort studies on the perceived overall discomfort or the recalled overall discomfort after attending a discomfort study.

4.1. Limitations
The study was conducted only with male participants between the ages of 20 - 35 in a narrow range of anthropometric measures. Therefore, the outcomes need to be seen as a first steps in investigating how secondary tasks can effect seating discomfort. Further research needs to extend to females and a larger range of anthropometric dimensions. Since no standard secondary task exists for discomfort studies, the choice of the used secondary tasks in this study needs to be discussed.

5. Conclusion
This study provides a first informative basis that the secondary task during discomfort studies does not affect the participants’ ratings of the perceived overall discomfort. The findings indicate, that there is no reason to take secondary tasks into account for designing discomfort studies. Nonetheless, there might be secondary tasks which affect discomfort ratings. Further studies should be conducted using other secondary tasks, based on a more detailed literature review.

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References


