Can You Ignore It? – Effects of Album Artwork on Driver Distraction

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Abstract

Influence of album artwork on driver distraction when searching for music albums was investigated in a driving simulator experiment with 24 participants. Participants searched music lists comprising of neutral artwork, attractive artwork showing half-naked men or women, or no artwork at all. It was expected that searching is more distracting when artwork is presented due to higher visual load. Further, attractive artwork was expected to be more distracting than neutral one. However, no significant distraction effects of album artwork were found. Attractive artwork seemed to capture somewhat more attention than neutral art. Results seem to suggest that drivers are able to ignore album artwork although the findings could be limited to search-oriented in-car tasks and unfamiliar artwork.

Introduction

Using portable music players such as iPods as well as online in-car infotainment systems while driving has become increasingly common. While these devices bring entertainment into the car they also come along with safety risks (see e.g., Lee et al. 2012).

Presenting album artwork in music player user interface is a very common approach for various reasons, i.e. as an interaction element or for more aesthetic visual appearance. However, to date we have not found any peer-reviewed studies investigating its influence on driver distraction. Further, we do not know if artwork comprising of attractive content such as half-naked models could catch driver's attention up to a level that is associated with higher crash risk, i.e. due to prolonged in-vehicle glances (Klauer et al. 2006). NHTSA (2013) has recently published guidelines for in-vehicle devices regarding the presentation of "non-driving-related graphical or photographic images", and the guidelines have provoked a lot of discussion on the effects of the images on drivers' behaviors.

Considering the potential influence of attractive roadside advertisement on drivers it becomes clear why this question is of importance. In 2005, Reuters reported on a survey conducted by Privilege Insurance revealed that a roadside advertisement presenting semi-naked model distracted about 25 percent of British male drivers (Reuters 2005). Artwork represented on in-car head units (HU) is nowadays often clearly visible on big screen, which allows perceiving images clearly and constantly by the driver (see Figure 1).

Figure 1 Mobile music player mirrored on in-car head unit (http://telpix.pl)

In this paper, we address the lack of empirical studies on distraction effects of album artwork and aim to find out:

- Whether searching for music is more distracting when artwork is presented compared to when no artwork is shown?
- What are drivers' preferences regarding artwork?
- Whether attractive artwork catches more attention than neutral artwork or if drivers can ignore it? Are there gender effects regarding presence of attractive artwork?

It is expected that searching for music is more distracting when *unfamiliar* artwork is shown compared to when it is missing, due to higher clutter in terms of interface elements that convey information (Kim et al. 2011) as well as possible saliency effects of the images (Foulsham & Underwood 2009). On the contrary, familiar artwork could in fact facilitate the search but the analyses on these effects are left outside the current study. Here, we study the effects of unfamiliar album art by controlling that the participants do not know beforehand the contents of the music player library and that the target albums are mostly unfamiliar for the participants.

Moreover, attractive artwork is expected to catch more attention than neutral one. Based on eye tracking studies in sexuality research (Lykins et al. 2008) it is hypothesized that male drivers gaze longer at opposite-sex covers than those showing same-sex figures, whereas female drivers distribute their visual attention evenly between opposite and same-sex covers.

We studied these questions in a driving simulator experiment with a remote eye-tracking device. If there are any differences regarding album artwork presented, they should become visible by measures of fixation durations or positions, overall visual demands as well as visual sampling efficiency. If strong enough, these effects could become visible also on search task or driving performance.

Method

Design

In order to investigate the research questions a two-way multivariate mixed design was used. First independent variable (between) was the *gender* of the participants. A second independent variable (within) manipulated the *appearance of album covers* in a music player menu. There were three levels: *neutral album artwork*, *mixed album artwork* and *no album artwork*. In the neutral album cover condition the music player menu consisted of neutral CD covers that included colorful background and the name of the artist and album. The neutral covers did not present any humans. In the mixed album cover condition, covers showing half-naked man or woman replaced ten neutral ones. In no artwork condition a grey placeholder including a white music note icon substituted the album cover.

Main dependent variables were the measures of the efficiency of visual sampling and visual demands. Furthermore fixation data, driving performance and search task performance were evaluated.

Visual demands were quantified as total number of in-vehicle glances as well as average and total duration of in-vehicle glances. *Visual sampling efficiency* was assessed by maximum in-vehicle glance durations as well as the frequency of over-1.6-second (Wierwille 1993) and over-2.0-second in-vehicle glances. In order to have a normalized metric of visual sampling efficiency, percentages of over-2-second in-vehicle glances were analyzed (NHTSA 2013).

Average speed as well as lane keeping accuracy, operationalized by the number and duration of lane excursions, quantified *driving performance*. *Search task performance* was measured by task completion time as well as number of wrong albums selected.

Participants

12 male and 12 female volunteers between 20 and 56 years (M = 27, SD = 7.6) were recruited via university student pool. Aged drivers as well as those with little driving experience were excluded in order to diminish the known effects of aging (Wikman et al. 2005) and low driving experience (Wikman et al. 1998) on visual sampling efficiency. Experiment was conducted in English and all the participants had good command of the language. As gratification volunteers received one movie ticket voucher.

Apparatus

Experiment was conducted in a medium-fidelity driving simulator at Agora User Psychology Laboratory in Jyväskylä. Fixed-base driving simulator consists of parts of real car body and driving environment is projected on three screens (Figure 2). Front screen measures about 64 x 170 centimeters (1280 x 1024 pixels) and the two side screens 64 x 110 centimeters (1280 x 1024 pixels).

Driving simulation software, which was used to project the driving scene on the three simulator screens, is freeware available on-line (www.racer.nl) and the selected track imitated road-like conditions of Polish countryside. Simulated Ford Focus with automatic shifting was used during the experiment. Looped racetrack was chosen for practice. Software is able to log various telemetric data and the simulations are highly configurable.

Distance of participants' eyes and the front screen was about 125 centimeters, to the left side screen about 130 centimeters and to the right side screen about 150 centimeters. Despite the fixed distance to the screens the participants were able to adjust the distance of pedals and steering wheel for their comfort. 21.5-inch Dell touch screen monitor (1920 x 1080 pixels) with a SMI RED 500 Hz remote eye tracking system attached at the top was placed next to the driver's seat (Figure 2). Eye-tracker was attached to the monitor upside-down in order to enable touch screen functionality without blocking camera's view. Depending on participants' height the distance between their eyes and monitor varied between 60 to 80 centimeters.

Figure 2 Inside the driving simulator with the touch monitor and remote eye tracking system. The analog HUD meters are visible above the steering wheel.

Flash-demos simulating music player menu of 7-inch in-car HU were presented. The demos could not play music, but enabled participants to search for music albums in a list-style menu showing three albums per page. Albums were represented with the corresponding artist and album name. Each demo comprised a total of 45 music albums on 15 pages.

Three Flash-demo versions were available that differed only regarding album artwork (neutral, mixed or no covers). Each demo included three search task sets, which consisted all of the same music albums, however they were ordered differently in each set. Moreover the orders of task sets per condition per participant was varied and counterbalanced. Target items were located between 37th and 45th positions.

Additional equipment included three paper questionnaires, laptop for starting Flash-demos and another one for operating as well as capturing data received by remote eye tracking system, as well as Sony HD video camera to record participant's eye movements for scoring in-vehicle glance durations after the SAE J2396 standard (SAE 2000).

Stimulus Material

Neutral artwork consisted of regular CD covers that did not show any humans. They only consisted of a colorful background or picture and stated the artist and album names. Neutral covers that did not represent mainstream music were selected in order to control familiarity effects on search efficiency. Attractive artwork in the *mixed album artwork* condition represented real CD covers as well, but they would show half-naked man or woman.

In a pre-study 40 male and female volunteers were shown a selection of such covers and asked to rate their attractiveness. Top-five rated male and female covers were then taken as stimuli in the attractive cover trials. One could argue there are a number of confounding factors affecting attractiveness of an album cover, such as visual complexity, colours, symbols etc. However, the neutral albums were intended to act as a baseline that together with the attractive covers varied randomly regarding these other factors. The difference was meant to be solely in the sexual attractiveness of the album art. Figure 3 provides some examples of the neutral and attractive artwork.

Figure 3 Examples of neutral (top) and attractive (bottom) artwork

Procedure

At the beginning of the experiment participants were informed about contents of the study and the procedure. They filled out a pre-task questionnaire focusing on demographic data. After this pedals and steering wheel were adjusted for the participants. In order to get used to the simulator they practiced driving on a looped track until they felt they had sufficient practice.

Participants were instructed to drive as accurately as possible. This meant to keep speed between 40 – 60 km/h and to keep vehicle on the right hand lane. Two head-up-display (HUD) meters served as indicators for vehicle's position (Figure 2). If HUD meters were positioned between white lane markers the vehicle was considered to be on the lane. In order to prevent participants from merely observing meters and lane markings, and hence, ensure more natural visual behavior, they were informed that there is a possibility for unexpected events while driving.

After the driving practice participants were familiarized with the music player. They were allowed to practice scrolling of the lists without driving until they felt comfortable with it.

Each participant had to complete three dual-task trials and one driving trial in order to collect baseline driving performance data. Dual-task trials differed regarding the appearance of album covers (neutral vs. mixed vs. no cover) and consisted of three search tasks each. Order of the dual-task trials and baseline drive was varied and counterbalanced across all participants. All trials were driven on the same road, while every second block was driven in opposite direction in order to control for unwanted learning effects.

Experimenter gave the search task by saying the artist name. If participants did not understand the name or had forgotten it they could ask to have it repeated. After they selected an album a short pause of a few seconds was given before the next search task was initiated. First task of each trial was given once the vehicle speed reached 40 km/h. Following tasks started at random points on the road depending on participant's performance.

Each search task was self-paced and participants were instructed that driving should be their first priority. To highlight the importance of prioritizing driving 12 most accurate drivers received an additional movie ticket.

In the end, participants were given a post-task questionnaire in which they were asked to indicate whether they had heard before of the artists they were searching for. Further, a short interview was conducted. Main questions of interest were: "Did you notice that there were some covers showing half-naked man or woman?", "Do you prefer to see an album cover when searching for music?", and "When searching for an music album, do you focus on the album cover or on the text?".

Analysis

Independent variables were the appearance of the album artwork and gender. Main dependent variables measured visual demands, visual sampling efficiency, driving performance, search task performance as well as fixation durations and positions.

A single research assistant manually scored the glance durations at the touch screen monitor frame-by-frame (25 frames per second) obeying the SAE J2396 standard for in-vehicle glance scoring (SAE 2000) with the help of Noldus Observer XT video analysis software. Usage of single coder minimized the variance in scoring techniques and thus, analysis of inter-coder reliability was not needed. Average speeds as well as lane keeping accuracy were captured in the driving simulation log file and calculated with a Python script.

Search task performance was quantified by task completion times and number of wrong albums selected. Flash-demos were able to store the task completion times. Failures in the search tasks were written down in real time by experimenter.

Fixation data was analyzed with SMI BeGaze video analysis software.

For statistical analysis mixed-model ANOVA (*gender* x *artwork*, 2 x 3) with alpha level of .05 was used. For within subject comparisons on visual demands, visual sampling efficiency, search task performance, fixation positions and durations Bonferroni correction with SPSS-adjusted significance level of .05 was applied. For analysis of

driving performance mixed-model ANOVA (*gender* x *trial*, 2 x 4) with alpha level of .05 was used. Contrast coding via simple contrasts was employed to test the research hypotheses.

For each ANOVA assumptions of normality, homogeneity of variance and sphericity were confirmed. If assumption of sphericity was violated the degrees of freedom were adjusted via Greenhouse-Geisser correction. Partial eta-square was calculated as a measure of effect size.

Results

Due to technical problems with the HD camera, recordings of eye movements of one male participant are missing and could not be included in the analysis. Thus, total sample size is 23 participants (12 females, 11 males) for the analyses of visual sampling efficiency and visual demands. Further, due to the upside-down configuration of the remote eye-tracker and touch screen monitor, it was difficult to calibrate the eye tracker for the majority of participants. Accurate fixation data is only available for nine participants (five females, four males). Analysis of driving performance and interviews includes all the 24 participants.

Visual Sampling Efficiency

No significant main effect of artwork on maximum glance durations was found. Contrast analysis revealed an interaction effect (*cover* x *gender*) for neutral – attractive (i.e. *mixed condition*) on maximum glance duration, $F(1,21) = 9.142$, $p = .006$, partial $\eta 2 = .303$. While maximum glance durations increased for males when viewing attractive covers, they decreased for female participants (Figure 4).

Means of over-1.6-second glances and over-2.0-second glances are shown in Figure 5. No significant main or interaction effects of album artwork or gender were found. Neither did the percentage of over-2-second-glances indicate any significant effects of gender or album artwork (Figure 6).

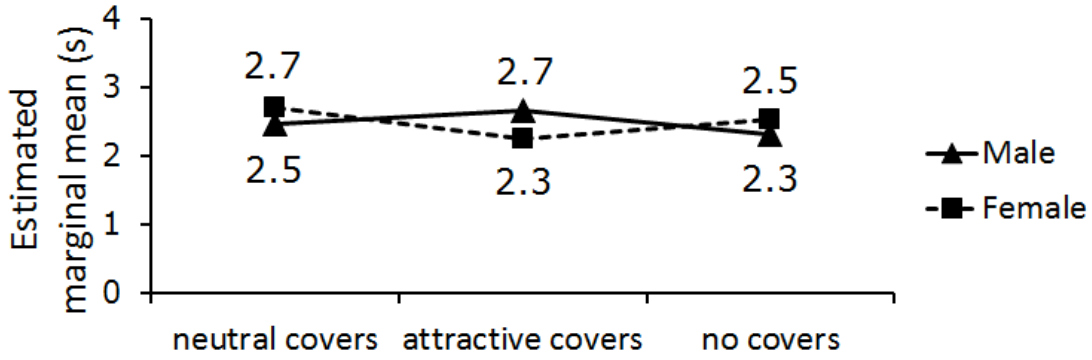

Figure 4 Maximum in-vehicle glance duration for all conditions

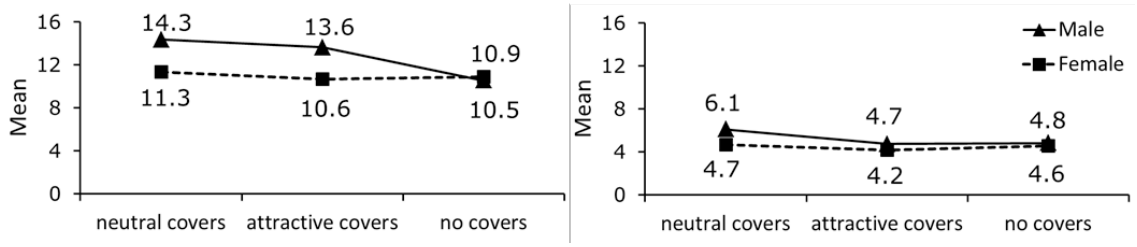

Figure 5 Number of over-1.6-second (left) and over-2.0-second in-vehicle glances (right) for all conditions (Means)

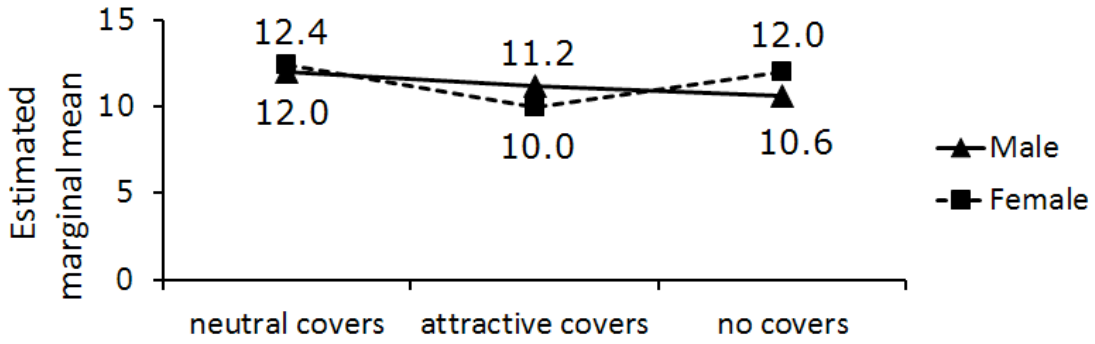

Figure 6 Percentage of over-2.0-second in-vehicle glances for all conditions

Visual Demands

No main or interaction effects of artwork or gender on average in-vehicle glance duration were found (see Figure 7). For total in-vehicle glance time contrast analysis revealed an interaction effect (*artwork* x *gender*) for *neutral – attractive*, $F(1,21) = 6{,}375$, $p = .020$, partial $\eta 2 = .233$. While total in-vehicle glance time increased for females when viewing attractive covers, it decreased for male participants (Figure 8). No main effects were found.

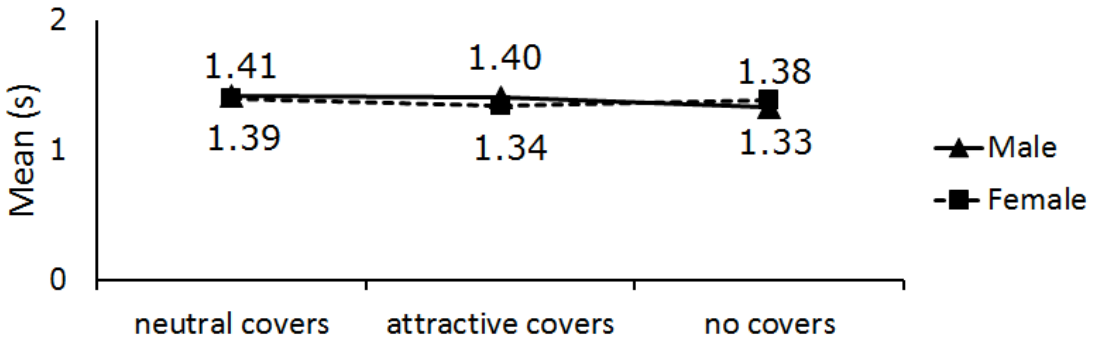

Figure 7 Average in-vehicle glance duration for all conditions (mean)

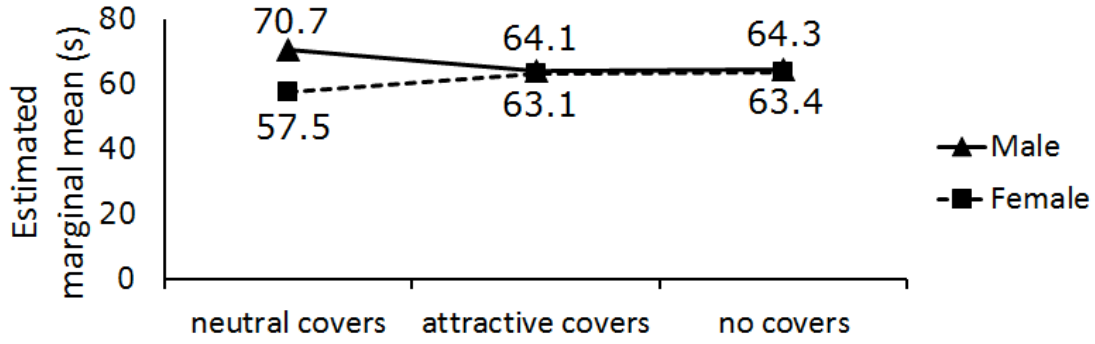

Figure 8 Total in-vehicle glance time for all conditions (three tasks)

An interaction effect (*artwork* x *gender*) for *neutral – attractive* was also revealed on number of in-vehicle glances, $F(1,21) = 9.411$, $p = .006$, partial $\eta 2 = .309$. There was a higher number of in-vehicle glances for females when attractive covers were present, whereas for males the number decreased (Figure 9). No main effects of artwork or gender were found.

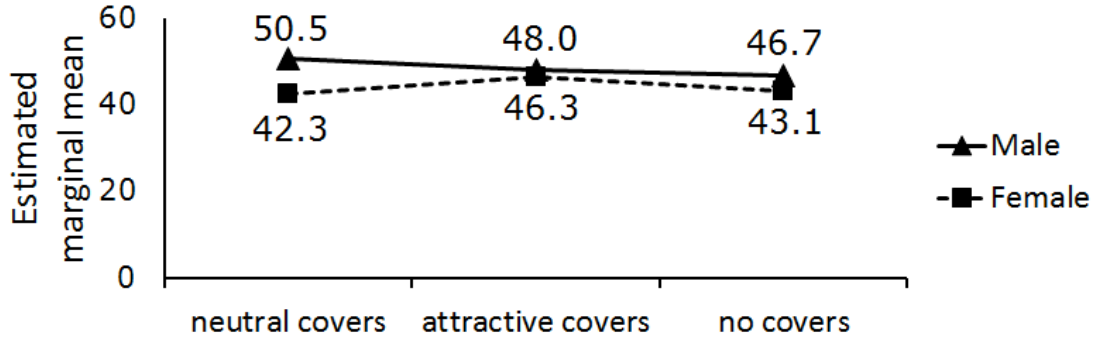

Figure 9 Number of in-vehicle glances for all conditions (three tasks)

Fixation Durations and Positions

Average fixation durations and positions on x-axis for search sets including *neutral covers* or *no covers* are presented in Figure 10. The larger the x-coordinate, the closer the fixation was on the *album cover* area. No significant effects of album artwork on fixation duration or position were found with this small sample size ($n = 9$). Average fixation position was located on the *artist label* area (Figure 11).

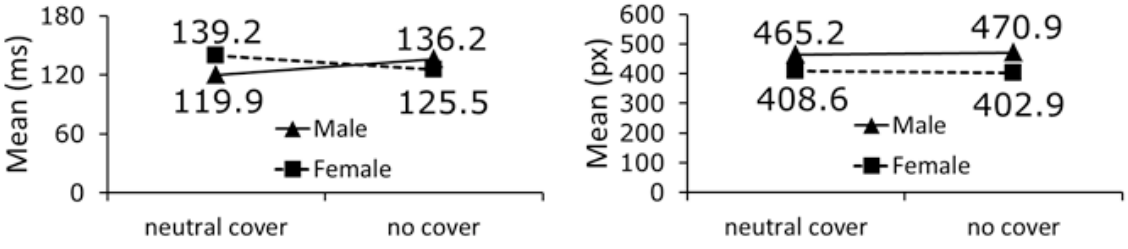

Figure 10 Fixation duration (left) and position on x-axis (right) for trials "neutral cover" and "no cover" (means)

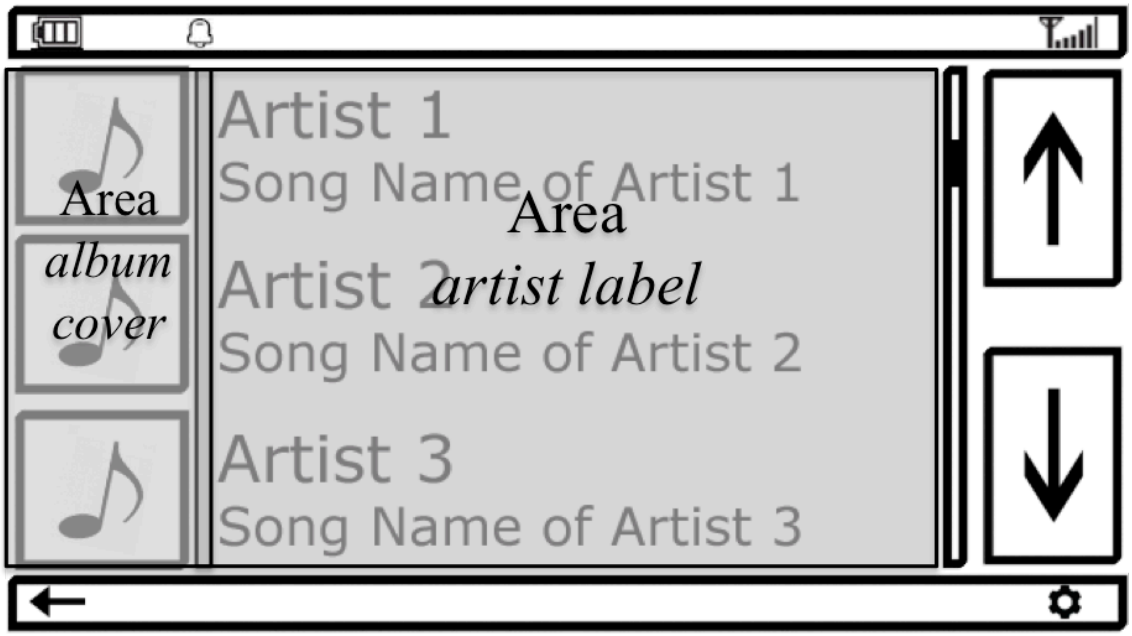

Figure 11 Areas of interest "album cover" and "artist label"

Figure 12 provides an overview of average fixation durations and positions for *mixed* cover trials, which consisted of neutral as well as attractive male and female covers. Attractive artwork did not have significant effect on fixation durations or positions with this sample size. Again average fixation positions landed at the artist label area. However, deeper analyses revealed an interesting effect of album art when comparing average fixation positions between *Female*-, *Male*-, *Neutral*, and *No cover*-trials (Figure 13). There were significant differences between *Female cover*- and *No cover*-trials, p = .023, with mean difference of 27.7 pixels (on the display of 1980 x 1080 pixels), as well as between *Male cover*- and *No cover*-trials p = .015, with mean difference of 30.5 pixels, but not between *Neutral*- and *No cover*-trials. There was also a near significant gender effect, $F(1,7)$ = 4.412, p = .074, partial $\eta 2$ = .387. Males' average fixation position appeared to be closer to the *album cover* area in general.

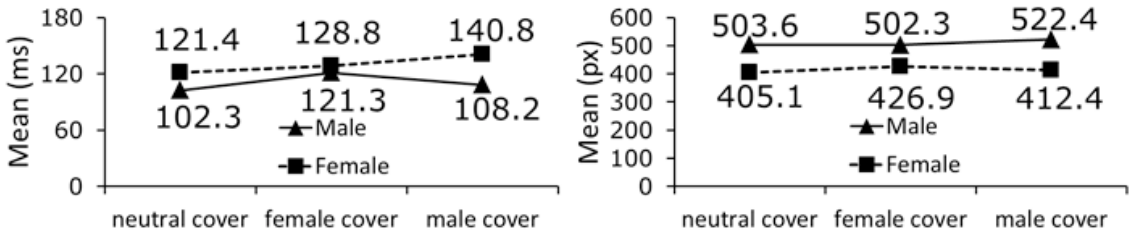

Figure 12 Fixation duration (left) and position on x-axis (right) for "mixed cover (incl. attractive covers)" trials (mean)

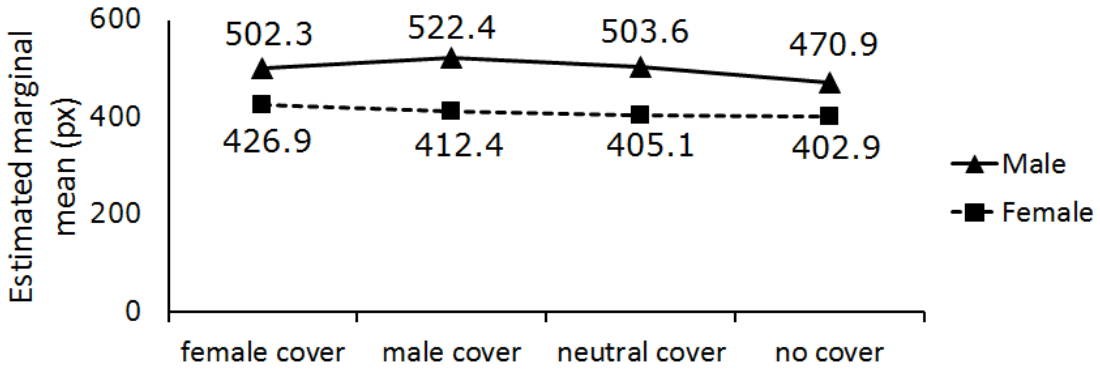

Figure 13 Fixation position on x-axis for "female", "male", "neutral" and "no cover" trials

Driving Performance

Speed Maintenance

No significant effects of artwork or gender on average vehicle speeds were found (see Figure 14). Numbers of speed violations per kilometer were generally low and there were no significant differences. Significant difference between all the dual-task conditions and baseline was revealed indicating that speeds were reduced during the dual-task trials, $F(3,66) = 7.661$, p=.000, partial $\eta 2 = .258$. Post-hoc tests revealed significant mean differences on average speed from *baseline* to *neutral*, from *baseline* to *attractive*, and from *baseline* to *no cover* conditions, which are presented in Table 1.

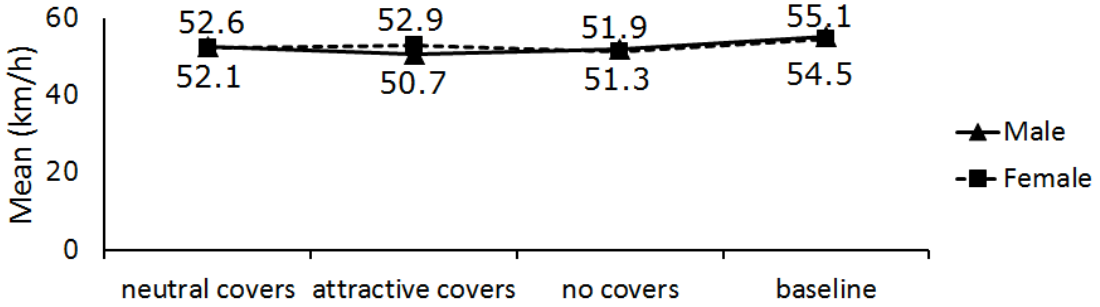

Figure 14 Average speeds for all conditions (mean)

Table 1 Significant mean differences on speed maintenance

Conditions		Mean difference (km/h)	Significance
Baseline	Neutral	-2.38	.001
Baseline	Attractive	-3.00	.006
Baseline	No cover	-3.14	.001

Lane Keeping Accuracy

No effect of artwork or gender on lane keeping accuracy was found. There were also no significant differences between dual-task and baseline conditions (see Figure 15).

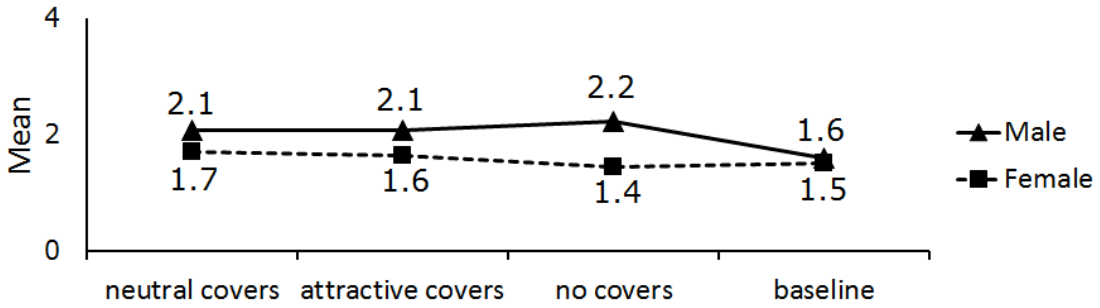

Figure 15 Number of lane excursions per kilometer for all conditions (mean)

Search Task Performance

Failures in search tasks were very rare. Only two mistakes in total were made in the neutral- and attractive cover-tasks.

Search task completion time did not indicate significant main effects of artwork or gender, but an interaction effect (*gender* x *artwork*) for *neutral – attractive* was found, $F(1,22) = 7.128$, $p = .014$, partial $\eta 2 = .245$. Females spent more time when attractive covers were presented, whereas male participants searched longer with neutral artwork (Figure 16).

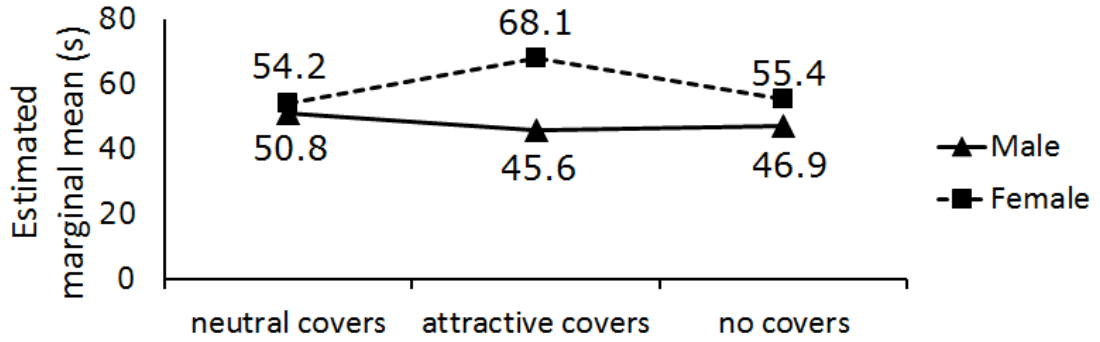

Figure 16 Search task completion times for all conditions

Interviews

-Have you heard before of the artists you were searching for?

Most participants had heard previously of "*Paul Simon*" (83.3 percent), some of "*Atmosphere*" (29.2 percent) and "*Girls Aloud*" (25 percent). The other artists were familiar to only a few or single participants.

-Did you notice that a half-naked man or woman was shown on album covers in one search set?

All the participants reported to not have recognized these covers.

-When searching for music do you focus on the artist label or the album cover?

79.2 percent reported to have concentrated on the text label. Other participants (20.8 percent) stated that if they know the look of an album cover they would focus on the cover.

-When searching for music do you prefer to see an album cover?

Slight majority of participants (54.2 percent) stated they prefer to *not* see an album cover when searching for music while driving. Nonetheless, 41.7 percent stated that they do like to see covers when searching for music while driving. Most reasoned that if they know the look of an album cover it might help to recognize it faster than having to read all the labels. Two reported that having an album cover just looks prettier.

Discussion

Aim of this experiment was to investigate distraction effects of album artwork. Specific questions included: if searching for music is more distracting when artwork is presented compared to when no artwork is shown, what drivers' preferences are, and if attractive artwork catches more attention than neutral artwork.

It was expected that searching for music with unfamiliar artwork present is more distracting compared to when album covers are missing. However, the results do not support this hypothesis. No significant differences on any of the measures could be observed. Average fixation durations and positions were similar in both conditions and mainly focused on the area *artist label*. This is not a surprising finding in this type of experimental design in which the task is to search for a definite verbally provided target.

80 percent of participants stated to generally focus on the artist label when searching for a music track. The rest of the participants reported they would only look at covers if they knew what the artwork looks like. However, 42 percent reported to prefer to have covers visible when searching for music while driving. Interestingly, only two participants stated that their positive attitude towards album covers is based on aesthetic appeal.

None of the measures did support the hypothesis that attractive artwork is more distracting than neutral one. However, closer analysis on average fixation positions revealed that both women and men tended to fixate closer to album art when there was attractive art compared to the no cover-condition, whereas this was not the case with the neutral cover condition.

It is possible the effect on fixation positions is not necessarily due to the attractiveness of the album covers but perhaps due to the usefulness of them. The familiarity effect of the attractive albums was not controlled in the study. It is possible the participants were able to exclude the albums showing a familiar artist or an opposite gender figure to that of the target artist without the need to read the album title. In some cases the album cover may have caught just a little more attention from men, which could explain the slight rise in maximum glance durations compared to women from neutral to attractive covers. Even if participants did not report to have consciously been aware of the attractive album art, they could have utilized the artist figures for search. There could have also been saliency effects (e.g. Foulsham & Underwood 2009) of the album covers that have captured somewhat attention even if their conscious strategy was in reading

the labels. Future studies should collect more eye-tracking data at a detailed level in order to determine if these speculations are viable.

The participants did not know which albums were stored in the music player until they performed the first search task. While these regulations served to control confounders, in real life people often know the content of their music players. On the other hand, online in-car music services enable browsing of several thousands of unfamiliar albums. However, a setup where participants are familiar with the contents of the music player could help to determine if album artwork *supports* music search. Some statements given during post-task interview suggest a possible beneficial influence. Here our goal was to study *distraction* effects of (mainly) *unfamiliar* album art.

In this study, participants were highly search oriented and due to mostly unfamiliar album art, tended to focus on reading the titles. To better answer if drivers can ignore attractive album art, a more suitable task could be, e.g., to browse through all the music albums followed by selecting a favorite one. Moreover, participants were aware of the eye tracking. Research design in which they are *not* aware of it could bring very different results.

While this study mainly focused on revealing if album art can distract drivers, it should be noted that the entire task of searching music seemed to be quite demanding. All the search tasks complied with the NHTSA (2013) criteria regarding the percentage of over-2.0-second in-vehicle glances to be under 15 percent for the 85th percentile, but the total glance times were well above the criteria of 12 seconds. Further, one should be aware that visual demands were still high even though a 7-inch head unit display was available, compared to a 4-inch mobile device display that was used in a similar experimental setup by Lasch & Kujala (2012). Thus, a bigger screen does not necessarily imply it is less distracting. More research is needed in order to explore possible advantages of larger in-car displays compared to smaller smart phone or mobile music player screens.

As in previous research (e.g. Lasch et al. 2012) participants systematically reduced their speed in order to compensate for the increased workload when searching for music tracks. Based on the earlier research, we can say that this reduction in speed is not specifically due to the album art but due to the demanding multitasking on the wheel in general.

NHTSA (2013, p.138) guidelines for in-vehicle devices state that: "*Static graphical and photographic images displayed for the purpose of aiding a driver to efficiently make a selection in the context of a non-driving-related task (e.g., music) is acceptable if the image automatically extinguishes from the display upon completion of the task*". The current results support the conclusion that album artwork is not a more significant distractor than searching music with text labels only but the limitations of the study should be carefully considered when making conclusions.

It should be the aim of in-car service providers to design products that are as minimally distracting as possible. Lee et al. (2008) suggest task ignorability as one (design) factor that should be investigated besides task demands when evaluating distraction effects of in-vehicle tasks. With this study we tried to take the first steps towards this direction.

Conclusion

In this experiment our goal was to study *distraction* effects of *unfamiliar* album artwork and the ignorability of attractive album art. Album artwork or attractive album covers in particular did not seem to distract participants significantly with any of the used metrics. However, results also suggest that in future studies the positive search facilitating effects of familiar album art should be analyzed. Furthermore, a follow-up study should be run in a less search-oriented setting in order to grasp a more comprehensive picture of the distraction effects.

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