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PRELIMINARY INVESTIGATIONS OF THE VISUAL IMPACTS OF MASK WEARING

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Abstract Accelerated by the worldwide COVID-19 pandemic, mask wearing has become and is likely to remain a ubiquitous activity, especially in public spaces. Few published data on the impacts of wearing a mask on visual performance and comfort exist. We describe pilot studies carried out to begin to ascertain the impacts of wearing surgical masks on three types of visual tasks: reading, walking and searching, each performed at two light levels, with and without a mask. Objective data included reading time, walking time and number of collisions while walking, and search time. Subjective data included ease of seeing and visual comfort. Masks had little effect on reading and searching performance, and a limited impact on the number of collisions while walking. Seeing while walking was judged easier without a mask, and visual comfort while searching was rated lower with a mask.

Keywords: Visual performance; mask wearing; illumination.

1. INTRODUCTION

Wearing masks and other protective face/head gear (e.g., respirators, face shields) has become very commonplace since the beginning of the COVID-19 pandemic. These purport to reduce the transmission of droplets in breath exhaled by the wearer into the surrounding environment, and to limit the likelihood of some particles from entering the wearer's respiratory tract. Masks can also have impacts on vision and seeing. Abeysekera and Shahnavaz [1] assessed peripheral vision with half-face masks such as those used to reduce dust inhalation and found downward peripheral vision was reduced by 12° to 44°. In contrast, they found that full-face masks actually provided greater downward peripheral vision because their outer covers tended to be clear. Johnson et al. [2] and Dooly et al. [3] demonstrated that the effective reduction in visual acuity caused by factors such as condensation or dust accretion on clear surfaces was correlated with reduced visual task performance such as monitoring a visual display or hand-eye coordination. Otherwise, relatively few data on the visual impacts of mask wearing are available. To begin to address this concern, several pilot studies were carried out.

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2. METHODS

Three types of visual tasks were investigated: reading, walking and searching. Each task was carried out under two light levels and with and without a mask. The masks were standard rectangular pleated surgical masks with a white interior and a light blue exterior. Because of the ongoing COVID-19 pandemic, all experimental tests were carried out in three small (n=3 or n=4) groups (total number of participants, n=11) in order to minimize the number of people in the same room. Social distancing was practiced at all times. Masks were worn throughout experimental sessions by all participants and experimenters, except by a single participant at a time during a no-mask trial. Specific experimental procedures differed slightly among each group, and not every group utilized all of the same dependent measures. To minimize the impacts of differences among groups [4], all tests were performed under a within-subjects, repeated-measures experimental design.

Figure 1 shows examples of each type of task. The illumination levels on the tasks were 13-29 lux provided by overhead room lighting at the lower light level, and 63-115 lux supplemented by task lighting at the higher light level. The primary outcome measure for the reading task was the reading time for a block of text. For the walking task the primary outcome measure was the time to walk along a set course; a secondary outcome for a subset of participants (n=8) was the number of collisions with obstacles along the course. The primary outcome measure for the searching task was the time to find the relevant object (i.e., a coin located within a specific area of the floor). Participants in each group performed each task in a randomized order. One group (n=4 for the reading and walking tasks, n=3 for the search task) also assessed participants' subjective agreement (1=disagree very much, 3=neither agree nor disagree, 5=agree very much) with statements about whether the task was difficult or whether visual discomfort was experienced during each trial.

a.  b. 

c. 

Figure 1. a. Example of reading task (reading material located on table top). b. Example of walking task (along carpeted area; chairs served as obstacles). c. Example of search task (locating a coin on the tiled floor).

3. RESULTS

3.1. Performance Outcome Measures

Within-subjects analyses of variance (ANOVAs) were conducted on each of the outcome measures for the reading, walking and searching tasks. There were no statistically significant main effects ($p>0.05$) of either light level or mask wearing on reading time, nor on search time, nor were there significant interactions between light level and mask wearing on these outcomes. Figure 2a shows the mean time to complete the walking task under each combination of light level and mask wearing;

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the ANOVA for walking time revealed a statistically significant (n=11; $F_{1,10}$=4.97, p=0.049) effect of light level but not mask wearing, with no significant interaction (p>0.05). Walking times were shorter under the higher light level.

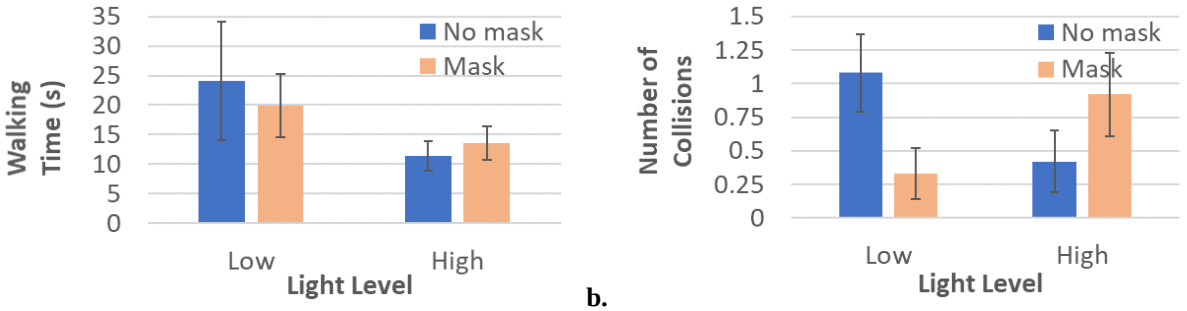

Figure 2. a. Average (+/- s.e.m.) time to complete the walking task for each combination of light level and mask wearing. b. Average (+/- s.e.m.) number of collisions under each combination of light level and mask wearing.

The ANOVA for the number of collisions during the walking task (Figure 2b) revealed a statistically significant (n=8; $F_{1,23}$=8.76, p=0.007) interaction between light level and mask wearing; fewer collisions occurred under the low light level while wearing a mask, but the opposite was true under the high light level.

3.2. Subjective Outcome Measures

Although subjective agreement data were collected from a small number of participants, several statistically significant effects were identified. For the reading task, a paired t-test showed that there was significantly greater agreement (n=4; t_4=8.66, p=0.003) that the task was difficult under the low (mean=4.25; higher values indicate greater agreement) than under the high light level (mean=1.75). For the walking task, paired t-tests indicated significantly greater agreement (n=4; t_4=4.70, p=0.018) that visual discomfort was experienced under the high light level (mean=4.5) than under the low level (mean=2.25), and significantly greater agreement (n=4; t_4=5.00, p=0.015) that the task was difficult while wearing a mask (mean=2.25) then when not wearing one (mean=1.0). For the searching task, a paired t-test suggested that there was significantly more agreement (n=3; t_3=5.20, p=0.035) that visual discomfort was experienced while wearing a mask (mean=4.0) than when not wearing one (mean=1.0).

4. CONCLUSION

These pilot studies were preliminary investigations of the effects of mask wearing on the performance and perception of several types of tasks. The interaction between light level and mask wearing on the number of collisions for the walking task illustrated in Figure 2b was the only significant relationship that involved mask wearing among the performance tests, and while masks may be associated with increased collisions at the higher light level, they seem to have been related to fewer collisions at the lower level. Participants walked more slowly at the lower light level and could possibly have been more cautious especially with a mask on, considering that people reported that wearing a mask increased difficulty and discomfort during the walking task. The illumination at the higher light level could also have contributed to glare reflected from masks under this level. Certainly, subjective

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impressions of mask wearing were more consistent, despite the even smaller sample sizes for these responses compared to the performance tests. Overall, these results suggest that while mask wearing has relatively small effects on short-term task performance, they can increase visual discomfort and perceived task difficulty, and this may have long-term impacts not addressed in this small study. It is hoped that this short paper will help shed light on a potential secondary consequence of increased mask wearing brought on by the COVID-19 pandemic.

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References

[1] Abeysekera, J. D. A., and Shahnavaz, H., 1987, Ergonomics assessment of selected dust respirators: Their use in the tropics, *Applied Ergonomics*, 18(4), pp. 266-272.
[2] Johnson, A. T., Dooly, C. R., and Brown, E. Y., 1994, Task performance with visual acuity while wearing a respirator mask, *American Industrial Hygiene Association Journal*, 55(9), pp. 818-822.
[3] Dooly, C. R., Johnson, A. T., and Brown, E. Y., 1994, Performance decrement due to altered vision while wearing a respiratory face mask, *Military Medicine*, 159(5), pp. 408-411.
[4] Skeskin, D. J., 2011, *Handbook of Parametric and Nonparametric Statistical Procedures (5th edition)*, CRC Press, New York.