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Correspondence: New methods for evaluation of discomfort glare

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At a recent international lighting research conference there were several presentations concerning the measurement of discomfort due to glare. These presented new research data and used the data to develop predictive models. One feature common to all of the studies was that discomfort had been evaluated using only a category rating procedure. A second common feature was that there were no steps for checking internal validity. These steps, such as control conditions or parallel procedures, provide evidence for responding to the question “why should we believe these data?”. We need to question validity because there are many reasons to suspect that the results of discomfort glare evaluations from category rating or other commonly used procedures are biased and possibly completely misleading.[1-5]

One common problem is stimulus range bias, the tendency for responses to be mapped to the range of stimuli chosen by the experimenter. Regardless of the range of visual scenes evaluated, range bias means it is likely that the scene prompting the least discomfort will be plotted at the lower end of the rating scale while the scene prompting the greatest discomfort will be plotted at the upper end of the rating scale.[2] Stimulus range bias also affects the adjustment procedure.[6] Range bias leads to two problems. First, experiments using different stimulus ranges will tend to reveal different thresholds: consideration of range bias may explain why one author’s data set is not well fitted by another author’s model, and thus question the need for yet another tentative model to be added. Second, any attempt to validate by repetition the findings of a previous study using a similar set of visual scenes and response scale is likely to provide validation by default: this is trivial because stimulus range bias means any other outcome would be unlikely.

Criticising the studies of others does not lead to constructive progress unless there is a response to the question “what should we do instead?” Presented here are five ideas for better ways to examine discomfort due to glare.

1. Continue using the conventional approaches (category rating and luminance adjustment) but attempt to disprove rather than validate a previous finding. This might be by using a different rating scale format and/or a different range of stimulus conditions. If a previous

finding is supported despite good attempts to disprove it, then it may be considered robust.

2. Seek the same evaluation but with a different question. Specifically, rather than ask for an evaluation of discomfort, ask for an evaluation of comfort. If the two approaches are equally valid, they should reveal the same comfort-discomfort threshold. This proposal follows the discussion of Halkjelsvik *et al* [7] who compared estimates of the time needed to complete a given task with estimates of the amount of work that could be completed in a given time.[7]
3. Continue using the conventional methods but develop new approaches to analysis. An example of this is the day-dark method for investigating perceived safety, specifically the optimal characteristics of road lighting for enhancing the reassurance of pedestrians.[8] The conventional approach is to evaluate, after dark, perceived safety in roads of different illuminance (or other characteristics) and seek that illuminance giving the highest rating of safety. That process tends to lead to the trivial finding that the higher illuminance is always perceived as safer, regardless of the range of illuminances included.[9] The day-dark approach captures evaluations of safety in daytime as well as after dark, and seeks lighting characteristics which minimise the day-dark difference. For discomfort glare this might be the difference in ratings between a test and standard lighting condition: at a minimum, such an approach might reduce variance due to between-subjects differences in discomfort tolerance. As a further example of alternative methods, consider the memory colours approach used to extend research of colour rendition characteristics.[10]
4. Consider behavioural or involuntary physiological responses rather than subjective evaluations (in other words, revealed preferences rather than stated preferences). Physiological measurements include direction of gaze, change in pupil size and EMG (electromyography, the intensity of the electrical activity in the muscles surrounding the eye).[11-14] Behavioural measurements include adaptive actions taken to counter glare such as shutting window blinds or changing seating position.[15] While such studies have been reported they appear to be far fewer than subjective evaluations and do not yet appear to be feeding in to discomfort glare models.
5. The final proposal is to recognise that absolute thresholds are an unrealistic target for subjective evaluations.[2] Absolute thresholds are, for example, the source luminance associated with a specific level of discomfort. We should instead consider only relative effects, for example that one scene offers a lower degree of comfort than a second scene. This approach could be utilised if a reference scene of an agreed level of discomfort were to be universally adopted.

As to which of these ideas will be productive, I do not know. But what I do suspect is that repeated use of rating scales in yet more discomfort glare evaluations is unlikely to lead to any breakthroughs in our knowledge of the discomfort due to glare.

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