Research Report

High Perceptual Load Makes Everybody Equal
Eliminating Individual Differences in Distractibility With Load

Sophie Forster and Nilli Lavie
University College London, London, United Kingdom

ABSTRACT—Perceptual load has been found to be a powerful determinant of distractibility in laboratory tasks. The present study assessed how the effects of perceptual load on distractibility in the laboratory relate to individual differences in the likelihood of distractibility in daily life. Sixty-one subjects performed a response-competition task in which perceptual load was varied. As expected, individuals reporting high levels of distractibility (on the Cognitive Failures Questionnaire, an established measure of distractibility in daily life) experienced greater distractor interference than did individuals reporting low levels. The critical finding, however, was that this relationship was confined to task conditions of low perceptual load: High perceptual load reduced distractor interference for all subjects, eliminating any individual differences. These findings suggest that the level of perceptual load in a task can predict whether individual differences in distractibility will be found and that high-load modifications of daily tasks may prove useful in preventing unwanted consequences of high distractibility.

The ability to ignore irrelevant distracting stimuli is of great relevance for everyday life, as the effects of distraction on behavior can have a range of consequences, some that are detrimental (e.g., during driving) and some that simply detract from the quality of life (e.g., during reading). It is therefore important to examine how attention theories that prescribe determinants of focused attention (and, conversely, distractibility) relate to people’s ability to ignore irrelevant distractors when focusing attention on relevant information in daily life.

The load theory of attention suggests that a major determinant of focused attention and the ability to ignore irrelevant distractors is the level of perceptual load in the current task (e.g., Lavie, 1995; Lavie, Hirst, De Fockert, & Viding, 2004). Although irrelevant distractors interfere with performance on tasks of low perceptual load (e.g., involving just one relevant stimulus), such distractor interference is eliminated on tasks of higher perceptual load (e.g., involving six or more stimuli; see Lavie, 2005, for a review).

To examine how this theory relates to distractibility in everyday life, we assessed how the effects of perceptual load on an individual’s magnitude of distraction in the laboratory relate to the extent to which the individual is likely to be distracted in daily life. The latter was measured with the Cognitive Failures Questionnaire (CFQ; Broadbent, Cooper, FitzGerald, & Parkes, 1982), the most established measure for individual differences in distractibility in everyday life.

Subjects performed a typical perceptual-load-plus-distractor task (e.g., Lavie, 1995; Lavie & Cox, 1997; Lavie & Fox, 2000) that required them to search for one of two target letters in displays of either low perceptual load (an angular target letter among five Os) or high perceptual load (an angular target letter among five angular nontarget letters). An irrelevant peripheral distractor letter was also present in each display, and subjects tried their best to ignore it. The irrelevant distractor was either the same as the search target in the display (compatible conditions) or the same as the other search target (incompatible conditions). Distractor-compatibility effects on reaction times (RTs) were our measure of the extent to which people were distracted.

Subjects’ magnitude of distraction under conditions of low and high perceptual load was related to their CFQ scores. The CFQ...
requires respondents to rate the frequency with which they experience 25 common types of cognitive failures. For example, the questionnaire asks, “How often do you start doing one thing at home and get distracted into doing something else (unintentionally)?” and “How often do you find you accidentally throw away the thing you want and keep what you meant to throw away—as in the example of throwing away the matchbox and putting the used match in your pocket?” CFQ scores correlate significantly with ratings of respondents by their spouses (Broadbent et al., 1982). Moreover, CFQ scores remain stable over time (Broadbent et al., 1982) and may even reflect a genetic predisposition, as the correlation of CFQ scores is around .5 between monzygotic twin pairs but drops to around .25 for dizygotic twin pairs and .2 for parent-offspring pairs (Boomsma, 1998).

High CFQ scores have been associated with increased frequency of car accidents (Larson & Merritt, 1991), injuries from falling (Larson, Ahldert, Neideffer, & Underhill, 1997), and accidents at work among electrical workers (Wallace & Vodanovich, 2003), as well as with a clearly less detrimental failure but nonetheless one that detracts from quality of life: losing work through failure to regularly save files when using a computer (Jones & Martin, 2003). These consequences of high distractibility suggest that it is highly important to ask whether high perceptual load can prevent distraction for all people, even those who are highly distractible and are particularly likely to be involved in various accidents. To address this question, it was first important to establish that individual differences in the likelihood of daily-life distractibility relate to the magnitude of distraction in our laboratory task. Specifically, we expected that people with high scores on the CFQ measure of daily-life distractibility would exhibit greater distractor effects in our task than would people with low CFQ scores. Our key prediction, however, concerned the effect of perceptual load on these individual differences. If high perceptual load can eliminate distraction for all people, then individuals with high CFQ scores, compared with those with low CFQ scores, would be expected to show greater interference from the irrelevant distractor in conditions of low perceptual load but not in conditions of high perceptual load.

METHOD

Subjects
Sixty-one volunteers (33 females; mean age = 25 years, range = 19–38) from the subject pool at University College London participated in exchange for £4. Two subjects (1 male) had 45% and 43% error rates in the high-load condition and were therefore excluded from the analyses.

Stimuli and Procedure
Subjects performed a perceptual-load task closely based on the one used by Lavie and Cox (1997, Experiment 1; see also Lavie, 2005, for a stimulus figure). E-prime was used to present the stimuli on a 38-cm computer screen placed 60 cm away from the subjects. Each trial started with a 500-ms presentation of a central fixation point, which was immediately followed by a 100-ms presentation of the task display. The task display consisted of a circle (1.6° radius) of six letters centered at fixation, plus a peripheral distractor letter, presented to the left or right of the circle, 1.4° away from the nearest circle letter. All the stimuli were presented in white on a black background. Each of the circle letters subtended 0.6° by 0.4°, and the distractor letter subtended 0.8° by 0.5°. The search targets were X and N. Each circle contained one target, and subjects were instructed to indicate which of the target letters was present in the circle by pressing either the “0” or the “2” key on the numerical pad of the computer as quickly as possible while not sacrificing accuracy. The distractor letter was equally likely to be X or N, and subjects were instructed to ignore the distractor. In the high-load condition, the letters H, M, K, Z, and W were placed randomly in the nontarget circle positions in a different order on each trial. In the low-load condition, the nontarget letters were all small Os (0.15°). Target position, distractor position and identity, and their combinations were counterbalanced.

Following 3 slower example trials and 12 practice trials from each load condition, subjects completed eight low-load and high-load blocks of 96 trials each in an ABBAABBA order. The CFQ (Broadbent et al., 1982) was then administered.

RESULTS

Overall Performance
Correct RTs (within the range of 100 ms to 1,500 ms) and error rates were subjected to within-subjects two-way analyses of variance. Both dependent variables showed significant effects of load and distractor compatibility. High (compared with low) load significantly increased the RTs, \( F(1, 58) = 225, p < .001, \eta_p^2 = 795 \), and the error rates, \( F(1, 58) = 86.7, p < .001, \eta_p^2 = 599 \). Incompatible (compared with compatible) distractors also significantly increased the RTs, \( F(1, 58) = 77.5, p < .001, \eta_p^2 = 572 \), and the error rates, \( F(1, 58) = 45.2, p < .001, \eta_p^2 = .386 \). But the more important result was that the interaction of load and distractor compatibility was significant for both RTs, \( F(1, 58) = 38.5, p < .001, \eta_p^2 = .399 \), and errors, \( F(1, 58) = 11.610, p < .001, \eta_p^2 = .167 \).

As shown in Figure 1, this interaction reflected the fact that the distractor-compatibility effect was greater in the low-load condition than in the high-load condition. In the low-load condition, a robust distractor-compatibility effect was found both for RTs (\( M = 28 \) ms), \( t(58) = 11.109, p < .001, \eta_p^2 = .99, d = 2.89 \), and for errors (\( M = 4.3 \)%), \( t(58) = 7.417, p < .001, \eta_p^2 > .99, d = 1.95 \). In the high-load condition, a much smaller distractor-compatibility effect was found both for RTs (\( M = 6 \) ms), \( t(58) = 2.267, p = .027, \eta_p^2 = .91, d = 0.60 \), and for errors.
These findings provide a replication of previous findings that perceptual load significantly reduces distractor effects (e.g., Lavie & Cox, 1997).

Individual Differences

To test our hypotheses regarding the individual differences in distractibility, we divided subjects into a high-CFQ group and a low-CFQ group, using a median split of the CFQ scores (range = 19–82, Mdn = 41, SD = 13.87). To examine RTs, we used a mixed-model analysis of variance with the between-subjects factor of CFQ group and the within-subjects factors of load and compatibility. This analysis revealed no significant main effect of CFQ group, \( F(1, 57) = 2.414, p > .10, \, p_{rep} = .791, \eta_p^2 = .041 \), and no interaction between load and CFQ group (\( F < 1 \)). These results indicate that the CFQ groups did not differ in their search performance or in the effects of load on search. The more important finding, however, was a significant interaction between distractor compatibility and CFQ group, \( F(1, 57) = 4.67, p < .05, \, p_{rep} = .90, \eta_p^2 = .076 \). This interaction indicated that the distractor-compatibility effects were greater for the high-CFQ group than the low-CFQ group, thus validating that higher CFQ scores indeed reflect greater distractibility.

Critically, this interaction was qualified by a three-way interaction of distractor compatibility, load, and CFQ group, \( F(1, 57) = 4.831, p < .05, \, p_{rep} = .905, \eta_p^2 = .078 \). As predicted by the hypothesis that high perceptual load can eliminate distractibility for all people, and as can be seen in Figure 2, the distractor-compatibility effect was greater for the high-CFQ group than for the low-CFQ group in the low-load condition, \( t(57) = 3.3, p < .01, \, p_{rep} = .979, \, d = 0.88 \), but not in the high-load condition (\( t < 1 \)).

The correlations showed the same pattern: CFQ score correlated positively with the magnitude of the distractor-compatibility effect under low perceptual load (\( r_s = .22, p < .05, \, p_{rep} = .38 \), one-tailed), but not under high perceptual load (\( r_s = .025, p > .4, \) one-tailed).

The error results did not reveal any effects or interactions involving the CFQ groups, apart from a nonsignificant trend toward an interaction of CFQ group and load, \( F(1, 57) = 3.1, p = .083, \, p_{rep} = .336, \eta_p^2 = .052 \). This trend suggests that the increase in load was generally more detrimental to the accuracy of the high-CFQ group than to the accuracy of the low-CFQ group. All other \( p \) values were greater than \( .1 \).

**GENERAL DISCUSSION**

The present study establishes two important findings: First, people who report being more distracted than others in everyday life also show greater distraction in our laboratory task:

Fig. 1. Reaction time (top panel) and percentage errors (bottom panel) as a function of perceptual load and distractor compatibility. Error bars represent \( +1 \) SEM.

Fig. 2. Distractor-compatibility effects on reaction time (RT) as a function of perceptual load and score on the Cognitive Failures Questionnaire (low vs. high). Distractor cost was calculated as RT on incompatible trials minus RT on compatible trials. Error bars represent \( +1 \) SEM.
Irrelevant peripheral distractors produced a greater response-competition effect for people with high scores on the CFQ than for people with low scores.

This finding is important, as previous studies assessing the relation between CFQ scores and distractor effects in selective attention tasks (e.g., response-competition, Stroop-like, or negative priming tasks—Bloem & Schmuck, 1999; Broadbent, Broadbent, & Jones, 1986; Kane, Hasher, Stoltzfus, Zacks, & Connelly, 1994; Kramer, Humphrey, Larish, Logan, & Strayer, 1994; Martin, 1983; Tipper & Baylis, 1987; Von Hove, Mainemarre, & Vannier, 1998) have produced mixed results, have often used small samples or mixed young and elderly populations, and have not always precluded the possibility of eye movements in the task (see Larson & Perry, 1999, for the association between CFQ score and control of eye movements). By contrast, in the present study, higher CFQ scores were associated with greater distractibility in a large sample of young adults, in a task with brief display durations (100 ms) that preclude alternative accounts for the effects of attention in terms of eye movements (see, e.g., Fischer, 1987). These findings validate the CFQ score as a measure of distractibility and also suggest that the magnitude of the distractor effect in the low-load conditions of our task can be used to predict the extent to which people are likely to be distracted in everyday life.

Second, the significant interaction of perceptual load, distractor compatibility, and CFQ group indicates that people who report being more distracted in everyday life show more distractor interference in tasks of low perceptual load, but not in tasks of high perceptual load. High perceptual load reduced distractor interference for all subjects, high and low scorers on the CFQ alike, to the extent that individual differences were eliminated. These results are the first to establish the key role of perceptual load in determining whether individual differences in distractibility will indeed affect the extent to which individuals are distracted in a given situation. Our findings suggest that perceptual load is a potent and universal determinant of distractibility.

In addition to adding external validity to load theory, the findings suggest an important implication for daily life. Poor selective attention has been shown to have a negative effect on everyday life, not only in terms of increased risk of careless errors and accidents (as discussed in the introduction), but also in terms of academic failure; for example, teacher ratings of students’ attention (but not ratings of other problems, such as anxiety or oppositional behavior) have been shown to predict diminished academic achievement (Rabiner, Murray, Schmid, & Malone, 2004). Our finding that high perceptual load in a task reduces distractibility for all people, regardless of their score on the CFQ, suggests that modifications of daily tasks so that they involve high perceptual load may prove very useful for everyone, even for people who are highly distractible. For example, teachers and lecturers may be able to reduce the susceptibility of their audience to distraction from irrelevant information (e.g., other people passing by the window) by supplementing verbal explanations with task-relevant visual information (e.g., hand gestures, colorful presentations). Such modifications could prove particularly beneficial (e.g., enhance academic achievement) for individuals with poor attentional ability, who typically have a high level of susceptibility to distraction.

REFERENCES


(RECEIVED 7/19/06; REVISION ACCEPTED 8/30/06; FINAL MATERIALS RECEIVED 9/13/06)