Does Time Pressure Induce Tunnel Vision? An examination with the Eriksen Flanker Task by applying the Hierarchical Drift Diffusion Model

Nico Assink, Rob H. J. van der Lubbe, and Jean-Paul Fox

Abstract— Mental stress is often thought to induce a phenomenon denoted as tunnel vision, which may be characterized as a shrinkage in the size of the attentional focus. This seems to imply that potentially relevant information is not taken into account while making a certain decision. In experimental settings, an effective way to induce mental stress is the use of time pressure by employing strict response deadlines. We decided to use the Eriksen flanker task to examine whether time pressure induces tunnel vision. The effect of peripheral flanker stimuli on both response speed and accuracy was compared between low and high time pressure conditions in three experiments. Instead of focusing solely on the speed and accuracy of responses, we decided to use the hierarchical drift diffusion model to determine the values of relevant parameters that describe the underlying decision process: the response criterion (α) and the drift rate (ν). The results consistently revealed that time pressure reduced the response criterion. Importantly, incongruent flankers reduced the drift rate under high time pressure as compared to low time pressure. The latter pattern of results is not in line with the idea that mental stress induces tunnel vision.

Keywords—: drift rate, Eriksen flanker task, hierarchical drift diffusion model, response criterion, time pressure, tunnel vision,

I. Introduction

Imagine you are driving your car in a city when suddenly the car in front of you hits the brakes. You have to react to this unexpected event and better do it quickly. Your heart rate increases, you clench the steering wheel and your eyes widen while your foot releases the gas pedal and hits the brake. The only thing you see is the car in front of you and its brake lights. Thanks to your physical reactions to the sudden threat and your focused attention a crash is averted and the stream of cars starts to pick up speed again. Then, totally unexpected, a car crashes into the right side of your car. As you calm down and realize what just happened, you wonder how you ever could have missed that red traffic light.

In a stressful situation such as described above a phenomenon called tunnel vision seems to occur. Information from the attended part of the visual field is still fully processed, but visual clues from other parts of the visual field that would otherwise be detected remain completely unnoticed. Thus, tunnel vision may be characterized as a shrinkage in the size of the attentional focus. This supposed change in visual attention as a result of mental stress is often taken as a fact in applied settings, but the evidence from research is not that conclusive. The aim of the current research is to answer the question whether stress manipulated by varying time pressure induces tunnel vision.

Behavioral studies reported some support for tunnel vision as a result of different stressors. Reference [1] shows observed reduced performance on a secondary, peripheral signal detection task in hot and humid conditions. However, the results of an experiment reported by [2], who used an evaluative observer to induce stress, only partially confirmed the view that stress induces tunnel vision. In Dirkin's experiment, [2], participants had to identify the number of illuminated lights on any of three display panels, with one centrally located panel and two peripherally located panels placed at an angle of 70° to the left and right of the subject's median. The identification of the lights on the peripheral panels constituted the primary task, and identification of the lights on the central panel was the secondary task. Under stress, the performance on the primary task improved, however, the hypothesized decrease in performance on the secondary task was not found.

Results from other electrophysiological studies, in which time pressure was used as a stressor, do not match well with the idea that tunnel vision occurs as a result of stress. Reference [3] shows event-related potentials (ERPs) derived from the electroencephalogram (EEG) to examine the mechanisms underlying speed-accuracy trade-off (SAT). Participants in their study performed a choice reaction time (RT) task known as the Eriksen flanker task (e.g., [4]). In this task, participants have to respond to the identity of a centrally presented target stimulus with a left or right button press as fast and as accurately as possible. The target is accompanied by irrelevant flanker stimuli. On congruent trials, the flankers signal the same response as the target while on incongruent trials the flankers correspond with the opposite response. Participants typically respond faster and more accurate on congruent than on incongruent trials, indicating an inability to completely

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ignore the flankers. In the study of Osman et al. task instructions varied between blocks, emphasizing either speed or accuracy. Instructions emphasizing speed resulted in a later onset of the response-locked lateralized readiness potential (r-LRP), but did not affect the onset latency of the stimulus-locked version of this potential (s-LRP). These results indicate that speed-accuracy instructions only affected the portion of RT following the start of motor preparation. Osman et al. also determined effects on the P300 ERP component, which is thought to be primarily affected by changes in early processing stages such as stimulus evaluation. The peak latency of the P300 potential was affected by target-flanker congruency, with an earlier peak on congruent than on incongruent trials. The speed-accuracy instructions, however, did not affect the latency of this peak, adding support to the conclusion that only late processes are affected by speed-accuracy instructions.

Reference [5] the influence of time pressure in a simple response task is examined, a choice-by-location task and the Simon task by varying response deadlines. In both the choice-by-location task and the Simon task, they observed that time pressure had no influence on the s-LRP while it affected the r-LRP, which corresponds with the results of [3] with the Eriksen task. Another lateralized EEG potential, the posterior contralateral negativity (PCN/N2pc) was used to provide more information about the influence of time pressure on earlier pre-motoric processes. The onset of the PCN may be used as an index for the start of discriminative processing of the relevant aspect of the stimuli. A change in onset or peak latency of this potential caused by different levels of time pressure would indicate that attentional orienting was affected. No such effects were observed. Together, these findings accord with the view that time pressure does not affect early attentional processes, but only later motor processes. However, the Eriksen flanker task seems more appropriate for demonstrating the presence or absence of tunnel vision, as successful execution of this task seems to depend on the size of the attentional window.

In conclusion, there appears to be a discrepancy between the results of the EEG studies of [3] and [5], and the long held assumption based on earlier behavioral studies that stress induces tunnel vision. In an attempt to bridge the gap between studies using behavioral measures and studies using electrophysiological measures, we measured overt behavioral measures (speed and accuracy), and related them to properties of a model that has been proposed to reflect the underlying neurophysiological processes. More specifically, we incorporated both speed and accuracy information to determine the properties of the underlying response selection process by using the Hierarchical Drift Diffusion Model (HDDM, see [6]).

In the current study, an arrowhead version of the Eriksen flanker task was employed. The high overlap between stimuli and responses is known to result in a strong response conflict (e.g., see [7]). In this task version, participants are instructed to respond as fast and accurately as possible by pushing a left button if the centrally presented target arrow points to the left and a right button if the target points to the right. The target is flanked by two distractors on both sides that can either point in the same (congruent) or opposite direction (incongruent) as the target. In a neutral condition, two parallel horizontal lines were used as flanker stimuli. Incongruent flankers reduce the speed and accuracy of the responses, despite clear instructions informing the participant to attend only to the identity of the central target stimuli. Reference [4] interpreted this as an inability to completely ignore the irrelevant flankers. This congruency effect makes the task well suited to test for the presence of tunnel vision. Namely, in the case of tunnel vision the processing of the flanker stimuli should diminish leading to a reduction of the congruency effect.

The congruency effect can be manifested in both speed and accuracy. This poses a challenge in interpreting RT and proportion correct (PC) because of SAT. Participants may respond faster in a certain condition at the expense of accuracy or vice versa ([8],[9]). Thus, if speed and accuracy change in opposite directions, it may be difficult to interpret specific performance differences between conditions. If a manipulation results in a great increase in speed, but simultaneously in more errors, the question may be raised whether the manipulation made the task more or less difficult, as speed and accuracy cannot be directly translated into each other. The HDDM overcomes this problem as it allows for the comparison of different properties of the underlying decision process.

The HDDM is a prominent sequential sampling model for two-choice decisions. It assumes that evidence for a specific response accumulates over time from a noisy input signal ([6],[10],[11]). When enough evidence for a specific response has been accumulated the response will be executed. Figure 1 shows a graphical representation of the process and its parameters.

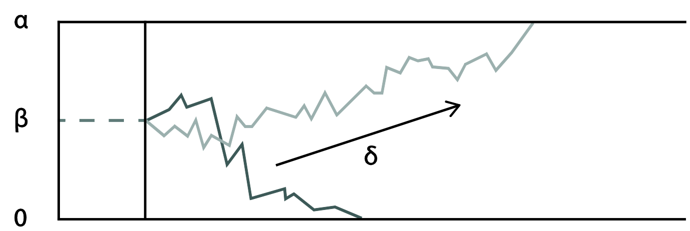

Fig. 1 A graphical representation of the hierarchical drift diffusion model (HDDM). α = response criterion; δ = drift rate per individual trial; β = bias. The history of two possible decision processes is shown, one reaching the top boundary, leading to a correct response, and one reaching the bottom boundary, leading to an incorrect response.

Evidence is thought to accumulate with an average rate per trial called the drift rate (v). The amount of evidence needed for a response is indicated by the boundary separation or response criterion (α). The initial starting point of the process is determined by β as a proportion of α. This value amounts to 0.5 in the case of no bias. The top boundary represents the evidence required to give a correct response while the bottom boundary indicates the evidence that will lead to an incorrect response. Another parameter τ represents the non-decision time, which is the time needed for all processes apart from the decision process, such as sensory processing and physically executing the response.

Our main interest is in effects on the parameters for the response criterion (α), and the drift rate (v). A high response

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criterion will result in slower but more accurate responses. This means that a change in α might explain the SAT phenomenon (e.g., see [12],[13]). For example, in a high time pressure condition, the size of the boundary separation may be reduced, enabling the participant to respond more quickly, but at the expense of accuracy. The value of the drift rate parameter (v) represents the average rate of evidence accumulation on a trial. Here, evidence means the amount of information regarding a specific response. On congruent trials all stimuli are likely to contribute evidence towards the correct response. On neutral trials, evidence can be sampled from the target, while the flanker stimuli only provide noise. On incongruent trials, sampling information from the flanker stimuli may actually reduce the amount of accumulated evidence. Thus, we may expect the drift rate to be largest on congruent trials, intermediate on neutral trials, and smallest on incongruent trials. If flanker stimuli would be completely ignored, which might occur in an extreme version of tunnel vision, then evidence should accumulate at the same rate in each condition, as the target always conveys the same amount of information about the correct response. If flankers are partially ignored due to tunnel vision, this should decrease the rate of evidence accumulation on congruent trials, while it should increase the rate on incongruent trials. The difference in drift rate between congruent and incongruent trials thus represents a congruency effect that informs us about the influence of flanker stimuli in a similar way as the congruency effects found in reaction time and accuracy, but now this is reflected in a single measure that is easier to interpret. Three experiments were carried out to examine whether time pressure indeed results in tunnel vision. Different task settings with varying interstimulus distances were employed as a variation in the distance between target and flankers might play an important role in the observed effects.

II. General Method

A. Overview and Apparatus

Three experiments were performed in which the same method was used. In these experiments, participants were seated in front of a 17” color CRT monitor at approximately 0.8 m viewing distance. Responses were given by pressing the left or right control (ctrl) key on a standard QWERTY keyboard with the corresponding index finger. Presentation software (Neurobehavioral Systems, Inc., 2012) was used for the presentation of instructions, stimuli, feedback, and for the recording of responses.

B. Stimuli and Procedure

Trial structure. A red rectangle (10° x 1°) containing a white fixation cross (0.7° x 0.7°) was presented on a black background in the center of the screen at the onset of a trial. After 750 ms the fixation cross was replaced by the target arrowhead pointing to the left or to the right. Four flankers were presented simultaneously, two on each side of the target. The four flankers were identical within each trial and were pointing either in the same direction as the target (congruent condition), or the opposite direction (incongruent condition), or they were equal signs (neutral condition). Stimuli and flankers were all 0.7° wide. Immediately after stimulus presentation, the color of the rectangle gradually faded from red to black, indicating the available time to respond. Feedback was provided immediately after a response or a missed deadline. The feedback consisted of a short text in Dutch which can be translated as „Correct”, „Incorrect” or „Too late”. In Figure 2, an overview of the events on a single trial is displayed. For incorrect and late responses, the text was accompanied by a loud 'buzzer' sound. The duration of the feedback was dependent on the duration of stimulus presentation, so that the total trial duration could be kept constant at 2500 ms.

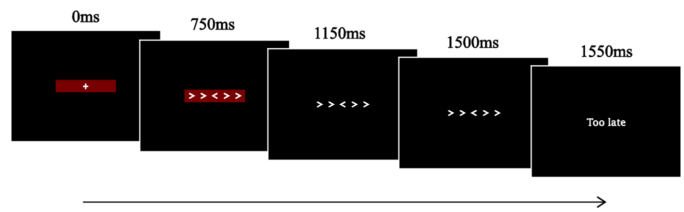

Fig. 2 The structure of a trial. An example of the various displays on a trial with a small interstimulus distance, incongruent flankers, low time pressure, and no response given before the deadline. Note that the color of the rectangle gradually changes from array onset at 750 ms till the response deadline at 1550 ms.

In the low time pressure condition, the response deadline was set at 800 ms after stimulus onset. At that moment the red background rectangle had become totally black. In the high time pressure condition the deadline, the moment at which the rectangle turned black, varied based on ongoing performance in order to keep time pressure on a relatively high level. At the start of a high time pressure block, the deadline was set at 450 ms. The available response time was reduced after two consecutive correct and fast-enough trials. After every incorrect or too slow response, the available time was increased. The initial step size for adjusting the deadline was set at 60 ms. After the first change in adjustment direction, the step size was reduced to 15 ms.

Procedure. A session began with a short oral introduction by the experimenter, followed by written instructions presented on the monitor. One very slow practice trial (with a 2000 ms deadline) was then presented. Next, a short instruction announced the start of a practice block of ten trials, indicating that responses had to be made faster as compared to the first trial as signaled by the faster color fading of the rectangle. After the practice block, the participant was asked if the task was clear. When the participant indicated to be ready, the experimenter left the experimental room, and the participant began with the first experimental block.

The experimental session consisted of eight blocks with a mandatory five minute break between the fourth and the fifth block. Low and high time pressure blocks alternated, but the session always started with a low time pressure block. Before each block, a short instruction was presented on the screen. The instructions preceding a low time pressure block stated that the response deadline was constant throughout the block. The instructions preceding a high time pressure block stated that the response deadline varied per trial.

A block consisted of 44 congruent trials, 44 incongruent trials and 22 neutral trials, with an equal number of left and right

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targets in each condition, resulting in a total of 110 trials per block. The trials within a block were presented in random order with the restriction that the same stimulus array was not repeated on more than three consecutive trials.

The first ten trials of each block were additionally regarded as practice trials, to enable the subject to adjust to the time pressure level of the block. Responses with the incorrect hand, premature responses (RT < 150 ms) and too slow responses (RT > 800 ms) were defined as errors. Note that responses made with the correct hand after the deadline but before 800 ms in the high time pressure condition resulted in negative feedback („too slow") but these responses were not treated as errors in the behavioral analyses.

The mean RT of correct responses and the mean PC was calculated for each participant in each of the experimental conditions. Mean RTs and PCs were submitted to an analysis of variance (ANOVA) for repeated measures. Greenhouse-Geisser ε correction was applied whenever appropriate. Significant effects were further examined using *t*-tests.

C. Hierarchical Drift Diffusion Model (HDDM)

We used the hierarchical version of the drift diffusion model developed by [6] called the HDDM. The HDDM allows the inclusion of all observed data (responses and reaction times) from all conditions and all participants in a joint analysis. In the HDDM, effects are allowed to vary over participants and conditions, enabling the analysis of multiple effects in one simulation. Following the notation of [6], we used indices to indicate the levels of differentiation and defined the Wiener distribution as follows:

$$Y_{(\mathrm{phij})} \sim Wiener\left(\alpha_{(\mathrm{ph})}, \beta, \tau_{(\mathrm{phij})}, \delta_{(\mathrm{phij})}\right),$$

The index *p* represents a participant, *h* a time pressure condition, *i* a congruency condition, and *j* an individual trial. The indices indicate that the value of the boundary α can vary across persons and across time pressure conditions, the value of β is invariant, and τ can differ across participants, time pressure conditions and trials. At the second level, for each time pressure condition, the boundary separation parameters $\alpha_{(ph)}$ are assumed to be normally distributed with an inter-participant mean and variance. The non-decision time parameter $\tau_{(phij)}$ is assumed to be normally distributed with a participant-specific mean ($\theta_{(p)}$) and standard deviation ($\chi_{(p)}$): $\tau_{(phij)} \sim \mathrm{N}(\theta_{(p)}, \chi_{(p)})$. The participant's mean is assumed to be sampled from a normal distribution: $\theta_{(p)} \sim \mathrm{N}(\mu_\theta, \sigma_\theta)$. The standard deviation, $\chi_{(p)}$,, representing the variability in decision time across participants, is assumed to be a priori uniformly distributed on a positively restricted interval, which specifies the variability in participants' standard deviations in the population. We allowed the drift rate parameter δ to differ on each trial, and assumed it is normally distributed with an intertrial mean $\delta_{(\mathrm{phij})} \sim \mathrm{N}(v_{(phi)}, \eta_{(p)})$. We further assumed that this participant-specific mean v is distributed according to an inter-participant normal distribution that differs across time pressure condition and experimental condition according to $v_{(phi)} \sim \mathrm{N}(\mu_{v(hi)}, \sigma_{v(hi)})$. The standard deviation of δ differs across participants, and is also uniformly distributed on a positively restricted interval. A graphical representation of this model and its assumptions is depicted in Figure 3.

In this model, the indices of α are *p* and *h*, which indicates that a value of α is defined for both time pressure conditions for each individual participant. The indices of drift rate include not only *p* and *h*, but also *i* and *j*, which indicates that a value for δ is estimated for every individual trial. Since we do not focus on individual trials, but on the general effects of time pressure and congruency, we will use its inter-trial mean $v_{(phi)}$ in our analysis of the drift rate.

Response data from the experiment were transformed in preparation of model parameter fitting. Most notably, RTs for both correct and incorrect responses were included, with RTs for incorrect responses being negated to distinguish them from correct responses.

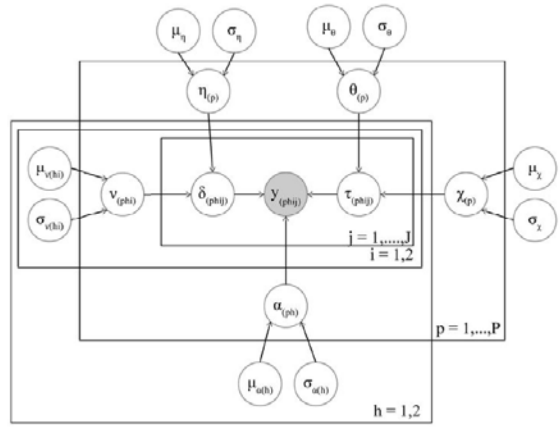

Fig. 3 A graphical representation of the hierarchical model used in our experiments. The shaded node y_{phij} represents the observed data (reaction times of correct and incorrect trials). The nodes α_{ph}, δ_{phij}, and τ_{phij} represent the main parameters of the model. The index *h* indicates the time pressure condition, and has two possible values. The index *i* represents the experimental condition. It has three possible values in Experiment 1 and 2 (representing the three target-flanker congruency levels), and six possible values in Experiment 3, where congruency and interstimulus distance are combined. The index *p* represents a participant, and the index *j* represents a trial. The boundary separation α_{ph} is allowed to vary between participants and time pressure condition, and is assumed to be normally distributed with an interparticipant mean $\mu_{\alpha(h)}$ and variance $\sigma_{\alpha(h)}$. The drift rate δ_{phij} can vary between individual trials, but is assumed to be normally distributed with an intertrial mean v_{phi} and variance η_p. The intertrial mean drift rate, v_{phi}, is assumed to be normally distributed with mean $\mu_{v(hi)}$ and variance $\sigma_{v(hi)}$. The non-decision time τ_{phij} can vary between trials, but is assumed to be normally distributed with a participant specific mean, θ_p, and variance, χ_p. Vague uniform priors were specified for the prior parameters η_p, θ_p, and χ_p.

The model definition and prepared data are used as input for a model parameter fitting process using software developed by [6]. This software uses Bayesian statistical methods to estimate parameter values. Two separate simulations, called chains, using the same model and the same data but different starting values for all parameters, were run for 10,000

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iterations. After this initial part of the simulation, convergence of both chains is checked using visual inspection and the Gelman-Rubin statistic for all parameters of interest. Convergence is reached if the original starting values of the estimated parameters have no influence on the current estimates. This was evaluated by comparing the values of the chains with different starting values. When we were satisfied that convergence had been met, another 30,000 iterations were run to create the posterior distribution. The results of the analysis are the posterior probability distributions of the parameters, which describes the estimated value and confidence interval after having observed the data.

Table 1. *Mean Reaction Times (RT) and Percentage of Correct Responses (PC) in Low and High Time Pressure Conditions.*

Distance	Time Pressure	RT Congruent	RT Neutral	RT Incongruent	PC Congruent	PC Neutral	PC Incongruent
Experiment 1							
1.4°	Low	398	404	436	97.9	97.8	91.6
	High	361	366	386	92.7	90.4	76.0
Experiment 2							
3.5°	Low	404	407	411	96.1	95.8	94.6
	High	362	368	368	84.4	84.0	81.5
Experiment 3							
1.4°	Low	396	402	419	96.4	94.4	94.1
	High	344	348	357	85.2	81.9	79.9
3.5°	Low	395	400	406	97.6	91.1	96.6
	High	346	347	351	86.6	84.1	74.1

The estimated mean parameter values for the response criterion α, and the drift rate v for each participant and each experimental condition were further analyzed using a repeated measures ANOVA.

III. Experiment 1

A. Method

Participants. Eighteen students (mean age 21 years, 12 females, 1 left-handed) with normal or corrected-to-normal visual acuity participated in this experiment. All participants signed an informed consent form and received course credits for their participation. The experiment was approved by the ethics committee of the Faculty of Behavioral Sciences at the University of Twente.

B. Stimuli and Procedure.

The stimuli and procedure used are described in the General Method. In this experiment the interstimulus distance was set at 1.4°.

Data Analysis. The model as defined before $Y_{(phij)} \sim$ Wiener($\alpha_{(ph)}$, β, $\tau_{(phij)}$,$\delta_{(phij)}$) was used with indices p for participants (p=1,…,P), h for time pressure(h=1,2), i for congruency condition (i=1,2,3), and j for trial(j=1,…,J). Where P = the number of participants (18) and J = the total number of included trials (14,352). We assumed no bias: β=0.5. After the first 10,000 iterations all parameters of interest had a Gelman Rubin statistic under 1.1. Visual inspection of the two chains showed no signs of convergence problems.

Results. After dismissing the first ten trials of each block as training trials, a total of 14,400 trials remained for the analyses. Of those trials, only three trials had premature responses (RT < 150ms), 45 trials had too late responses (RT > 800ms) or no response, and 1,320 trials had erroneous responses. The mean RTs and PCs for each combination of time pressure and congruency condition are shown in the upper panel of Table 1.

Mean RT for each condition was calculated for each participant and submitted to an ANOVA for repeated measures. Participants responded faster in the high time pressure than in the low time pressure condition, $F(1,17) = 141.2$, $p < 0.001$, $\eta^2_{partial} = 0.89$, indicating the effectiveness of our time pressure manipulation. The standard effect of flanker congruency was also observed, $F(2,34)= 48.9$, $p < 0.001$, $\varepsilon = 0.54$, $\eta^2_{partial} = 0.74$, with fastest responses in the case of congruent flankers and slowest responses in the case of incongruent flankers.

Our main interest concerned the possible interaction between time pressure and congruency. Tunnel vision was thought to result in a decreased congruency effect in the high time pressure condition. An interaction between time pressure and congruency was indeed observed, $F(2,34) = 13.5$, $p < 0.001$, $\varepsilon = 0.74$, $\eta^2_{partial} = 0.44$. The congruency effect was significantly smaller in the high time pressure condition (M=25, SD=17) as compared to the low time pressure condition (M=37, SD=19), $t(17) = 4.66$, $p < 0.001$. This reduced effect of target-flanker congruency under high time pressure might be an indication of tunnel vision.

Mean PC for each condition was calculated for each participant and submitted to an ANOVA for repeated measures. Participants were less accurate in the high time pressure as compared to the low time pressure condition $F(1,17) = 162.1$, $p < 0.001$, $\eta^2_{partial} = 0.91$. The congruency effect was also present, with the highest accuracy on congruent trials, and the lowest accuracy on incongruent trials, $F(2,34) = 29.7$, $p < 0.001$, $\varepsilon = 0.55$, $\eta^2_{partial} = 0.64$. As with RT, a significant interaction between time pressure and congruency was found, $F(2,34) = 25.9$, $p < 0.001$, $\varepsilon = 0.63$, $\eta^2_{partial} = 0.60$. However, in this case the congruency effect was larger in the high time pressure condition (*M*=16.8, *SD*=9.8) as compared with the low time pressure condition (*M*=6.4, *SD*=9.6), $t(17) = 6.0$, $p < 0.001$. Thus, in contrast with the RT findings, the PC data suggest an increased influence of flankers under high time pressure.

Table 2. Estimated Values for the Response Criterion (α) and the Drift Rate (ν), in Low and High Time Pressure Conditions.

Distance	Time Pressure	α	ν Congruent	ν Neutral	ν Incongruent
Experiment 1					
1.4°	Low	0.0856	0.6138	0.5786	0.3763
	High	0.0443	0.5966	0.5313	0.2680
Experiment 2					
3.5°	Low	0.0787	0.5143	0.4899	0.4551
	High	0.0398	0.4561	0.4223	0.3935
Experiment 3					
1.4°	Low	0.0866	0.5067	0.4789	0.3640
	High	0.0394	0.4981	0.4274	0.2733
3.5°	Low	0.0866	0.5038	0.4640	0.4313
	High	0.0394	0.4611	0.4045	0.3684

Together the PC and RT data cannot answer the question whether time pressure induced tunnel vision as increased time pressure resulted in a decreased influence of flankers on RT, but an increased influence on PC. Examination of the parameters estimated with the HDDM may help in understanding the influence of time pressure.

HDDM parameter estimates. After the first 10,000 iterations, convergence was checked and these iterations were discarded. The results of the remaining iterations were used to calculate the mean estimated values of the variables of interest. Table 2 shows the estimated means for the relevant parameters. The value of α represents the response criterion, where a higher value of α indicates a higher response criterion (i.e., a more conservative strategy). The time pressure manipulation resulted in a reduction of 48% of the response criterion, which was highly significant, $t(17) = 11.0$, $p < 0.001$. Thus, according to the model, the required evidence for a decision was largely reduced in the case of high time pressure.

The value of ν represents the drift rate or the rate of evidence accumulation. The mean values of ν depicted in Table 2 show three effects. First, a congruency effect was observed; the drift rate was highest on congruent trials, intermediate on neutral trials, and lowest on incongruent trials $F(2,34) = 118.5$, $p < 0.001$, $\varepsilon = 0.54$, $\eta^2_{partial} = 0.88$. Second, ν was smaller in the high time pressure than in the low time pressure condition, indicating a decrease in the drift rate under high time pressure, $F(1, 17) = 37.5$, $p < 0.001$, $\eta^2_{partial} = 0.69$. Third, the difference between congruent and incongruent trials was larger in the high time pressure condition (0.596-0.268 = 0.328) than in the low time pressure condition (0.614-0.376 = 0.238), $F(2,34) = 13.4$, $p = 0.001$, $\varepsilon = 0.65$, $\eta^2_{partial} = 0.44$. This observation suggests that flankers had a larger influence on the drift rate in the case of high time pressure than in the case of low time pressure.

C. Discussion

Time pressure resulted in faster but less accurate responses, indicating the presence of speed-accuracy trade-off. Responses on congruent trials were faster and more accurate than responses on neutral trials, and responses on incongruent trials were slowest and the least accurate. Thus, as demonstrated in numerous studies with the Eriksen task, the irrelevant flanker stimuli clearly affected performance. In the high time pressure condition, the congruency effect on RT was smaller than in the low time pressure condition. The congruency effect found on PC, however, was larger in the high time pressure condition than in the low time pressure condition. The RT data thus suggest a decreased influence of flankers under high time pressure, while the PC data suggest an opposite, namely increased effect of flankers. These results indicate that it is not possible to conclude that increased time pressure led to a decreased effect of flankers, which might be expected to occur in the case of tunnel vision.

Values for the parameters describing the underlying decision process according to the HDDM were estimated to provide insight in the observed effects. In the high time pressure condition, the value of α was much smaller than in the low time pressure condition, indicating that less evidence had to be accumulated before a decision was made. Thus, time pressure induced a lowering of the response criterion. The value of the drift rate ν was influenced by target-flanker congruency. As expected, evidence accumulated faster on congruent trials as compared to incongruent trials, indicating an influence of the task-irrelevant flankers. The drift rate, however, was also reduced in the case of high time pressure, suggesting that evidence accumulation was slowed down. This seems counterintuitive, as one might hypothesize that in the case of high time pressure extra attentional resources are allocated to the target leading to a higher drift rate by a mechanism denoted as gain modulation (e.g., see [14]). This issue will be addressed in the General Discussion. Importantly, the difference in drift rate between congruent and incongruent trials was estimated to be larger in the case of high time pressure than in the case of low time pressure, which seems mainly due to a decrease in the drift rate on incongruent trials in the case of high time pressure. This suggests that incongruent flankers had a larger negative effect on the accumulation of information in that condition. This pattern of results is completely opposite to the predicted effect in the case of tunnel vision. We hypothesized that if tunnel vision was induced, it should result in less processing of the flanker stimuli, and therefore a smaller congruency effect. Thus, no support was obtained for the view that time pressure induces tunnel vision.

In this first experiment, the interstimulus distance was set at 1.4°, resulting in a strong congruency effect. This relatively small distance could possibly explain the absence of evidence for tunnel vision. It may be that attention was more focused under high time pressure, but not sufficiently so to exclude processing of the flanker stimuli. To investigate this possibility, we increased the interstimulus distance to 3.5° in our second experiment.

IV. Experiment 2

A. Method

Participants. Twenty students (mean age 19.5 years, 15 females, 2 left-handed) with reported normal or corrected-to-normal visual acuity participated in this experiment. All participants signed an informed consent form and received course credits for their participation. The experiment was approved by the ethics committee of the Faculty of Behavioral Sciences at the University of Twente.

B. Stimuli, Procedure and Data Analysis.

The interstimulus distance was set at 3.5°. The width of the background rectangle was increased accordingly to fit the complete stimulus array.

Results. A total of 16,000 trials remained for analysis after dismissing the first ten trials of each block as practice trials. Twenty-three trials had premature responses (RT < 150ms), 63 trials had too late responses (RT > 800ms) or no response, and 1,627 trials had erroneous responses.

Table 1 shows mean RT and PC for each condition. A repeated measures ANOVA revealed that time pressure resulted in faster, $F(1,19) = 119.6$, $p < 0.001$, $\eta^2_{partial} = 0.86$, and less accurate responses, $F(1,19) = 91.7$, $p < 0.001$, $\eta^2_{partial} = 0.83$. A small but significant congruency effect was found, with slower, $F(2,38) = 10.4$, $p < 0.001$, $\varepsilon = 0.97$, $\eta^2_{partial} = 0.35$ and less accurate responses on incongruent as compared to congruent trials, $F(2,38) = 6.6$, $p = 0.003$, $\varepsilon = 0.96$, $\eta^2_{partial} = 0.26$. There was no significant interaction between time pressure and congruency, neither for RT, $F(2,38) = 1.6$, $p = 0.22$, $\varepsilon = 0.70$, $\eta^2_{partial} = 0.08$, nor for PC, $F(2,38) = 0.88$, $p = 0.43$, $\varepsilon = 0.89$, $\eta^2_{partial} = 0.04$. Pairwise comparisons additionally revealed that responses on incongruent trials were significantly slower, $t(19) > 3.6$, $p < 0.002$, and less accurate, $t(19) > 2.3$, $p < 0.037$, as compared to responses on congruent trials, both in the high and the low time pressure conditions. Responses on neutral trials (M=367, SD=29) were slower as compared to responses on congruent trials (M=360, SD=30) but only in the high time pressure condition, $t(19) = 3.3$, $p = 0.004$. Responses on neutral trials (M=84, SD=6) only differed significantly, $t(19) = 2.3$, $p = 0.034$, on PC with responses on incongruent trials (M=81, SD=7) in the high time pressure condition. All other differences between the neutral condition and the congruent or incongruent condition were not significant. Differences in RT between the low and high time pressure conditions were significant for all congruency conditions, $t(19) > 8.7$, $p < 0.001$, this was also the case for PC, $t(19) > 8.4$, $p < 0.001$.

HDDM parameter estimates. After the first 10,000 iterations, convergence was checked and these iterations were discarded as burn-in. Table 2 shows the mean estimated parameter values for α and v. The values for α show a similar pattern as in the first experiment, with a 49% reduction of the response criterion in the high time pressure condition, $t(19) = 11.2$, $p < 0.001$. The estimated means of v were submitted to a repeated measures ANOVA to examine the effect of flanker congruency and time pressure. As in the first experiment, the expected effect of flanker congruency was observed, $F(2,38) = 33.9$, $p < 0.001$, $\varepsilon = 0.96$, $\eta^2_{partial} = 0.64$, with the highest drift rate on congruent trials and the lowest drift rate on incongruent trials. The effect of time pressure on v was also replicated, $F(1,19) = 31.1$, $p < 0.001$, $\eta^2_{partial} = 0.62$, showing a reduction of the drift rate in the case of high as compared to low time pressure. No interaction effect between time pressure and congruency was observed, $F(2,38) = 0.4$, $p = 0.67$, $\varepsilon = 0.91$, $\eta^2_{partial} = 0.02$.

C. Discussion

Increased time pressure resulted in faster and less accurate responses, revealing again a tradeoff between speed and accuracy. The influence of the flanker stimuli on both speed and accuracy was small, but still significant. In contrast with our first experiment, time pressure did no longer affect the influence of flanker stimuli on RT and PC.

The effect of time pressure on the response criterion α was again clearly present, which suggests that less evidence was needed to emit a response in the case of high time pressure. The congruency effect was again reflected in the estimated value of the drift rate v, with the same pattern of results as in our first experiment, but the size of the effect was much smaller. In contrast with the first experiment, no interaction between time pressure and congruency was observed for v. A main effect of time pressure on v was present, with again a smaller drift rate in the case of high time pressure as compared to low time pressure.

Together, the HDDM estimates of both experiments revealed a decrease of the response criterion and a decrease of the drift rate due to increased time pressure. Furthermore, the drift rate slows down on incongruent as compared to neutral and congruent trials. The major difference between the two experiments concerns the presence of an interaction between time pressure and congruency on v in our first experiment and the absence of this effect in our second experiment. This difference seems likely due to the increased interstimulus distance. These results may be explained by precisely the opposite mechanism as tunnel vision, namely, a reduction in the efficiency of attentional allocation in the case of high time pressure. This may result in an increased flanker effect under high time pressure in Experiment 1, while the interstimulus difference in Experiment 2 may have been too large to exert an increased flanker effect.

An alternative possibility to be considered is the presence of different strategies in both experiments. To examine this, a third experiment was carried out in which interstimulus distance was varied. Trials with a small interstimulus distance and trials with a large interstimulus distance were randomly intermixed within all blocks, which will discourage the employment of different strategies. If the pattern of results found in the first two experiments is replicated then it seems that the observed differences were not due to the application of different strategies.

V. Experiment 3

A. Method

Participants. Seventeen students (mean age 22 years, 11 females, 1 left-handed) with reported normal or corrected-to-normal visual acuity participated in this experiment. All participants signed an informed consent form and received course credits for their participation. The experiment was approved by the ethics committee of the Faculty of Behavioral Sciences at the University of Twente.

B. Stimuli and Procedure.

The third experiment combines the previous experiments: the general method is the same but interstimulus distance was added as a within-subject variable. A block of trials now contained 110 trials with a small interstimulus distance and 110 trials with a large interstimulus distance, and these trials were randomly intermixed within each block. The number of blocks was the same as in Experiment 1 and 2.

Data Analysis. The same HDDM was used as in the first two experiments; no extra hierarchical level was added to include the factor interstimulus distance. Instead the combination of congruency and interstimulus distance implied that there were simply more levels of the stimulus factor. Thus, the structure of the HDDM remained the same, but the index i had now six instead of three possible values. After parameter fitting, mean parameter values for congruency and interstimulus distance were derived from the estimated parameters values for each stimulus condition. Interstimulus distance was included as an independent variable in the ANOVAs of α and ν.

Results. As in the previous experiments, the first ten trials of each block were dismissed as they were considered as practice trials. Of the remaining 28,560 trials, 291 trials had premature responses (RT < 150ms), 277 trials had too late responses (RT > 800ms) or no response, and 3,309 trials had erroneous responses. The mean RT and PC for each condition are depicted in the lower panel of Table 1. Time pressure resulted in faster, $F(1,16) = 164.3$, $p < 0.001$, $\eta^2_{\text{partial}} = 0.91$, and less accurate responses, $F(1,16) = 133.9$, $p < 0.001$, $\eta^2_{partial} = 0.89$. The congruency effect was also present on both RT, $F(2,32) = 45.1$, $p < 0.001$, $\varepsilon = 0.73$, $\eta^2_{partial} = 0.74$, and PC, $F(2,32) = 22.8$, $p < 0.001$, $\varepsilon = 0.79$, $\eta^2_{partial} = 0.59$, with fastest and most accurate responses on congruent trials, and slowest and least accurate responses on incongruent trials. Time pressure interacted with congruency on RT, $F(2,32) = 9.0$, $p = 0.001$ $\varepsilon = 0.88$, $\eta^2_{partial} = 0.36$, and on PC, $F(2,32) = 18.3$, $p < 0.001$, $\varepsilon = 0.72$, $\eta^2_{partial} = 0.53$, showing the strongest effect of time pressure on incongruent trials, both in a reduction of RT and a reduction of accuracy. Interstimulus distance had a main effect on RT, $F(1,16) = 10.9$, $p = 0.005$, $\eta^2_{partial} = 0.40$, with faster responses in the case of the largest interstimulus distance, but no effect was present on PC, $F(1,16) = 0.42$, $p = 0.526$, $\eta^2_{partial} = 0.03$. The interstimulus distance interacted with congruency on RT, $F(2,32) = 17.0$, $p < 0.001$, $\varepsilon = 0.91$, $\eta^2_{partial} = 0.52$, but not on PC, $F(2,32) = 3.2$, $p = 0.054$, $\varepsilon = 0.95$, $\eta^2_{partial} = 0.17$. No interaction was found between interstimulus distance and time pressure on RT, $F(1,16) = 3.7$, $p = 0.073$, $\eta^2_{partial} = 0.19$, and also not on PC, $F(1,16) = 1.3$, $p = 0.267$, $\eta^2_{partial} = 0.08$. The interaction between interstimulus distance, time pressure and congruency was significant for PC, $F(2,32) = 15.0$, $p < 0.001$, $\varepsilon = 0.80$, $\eta^2_{partial} = 0.48$, but not for RT, $F(2,32) = 1.1$, $p = 0.332$, $\varepsilon = 0.92$, $\eta^2_{partial} = 0.07$. Separate analyses for both interstimulus distances were performed to enable a direct comparison with the results of Experiment 1 and 2.

For trials with a small interstimulus distance, time pressure reduced both RT, $F(1,16) = 153.2$, $p < 0.001$, $\eta^2_{partial} = 0.91$, and PC, $F(1,16) = 120.1$, $p < 0.001$, $\eta^2_{partial} = 0.88$. The congruency effect was also found on both RT, $F(2,32) = 43.3$, $p < 0.001$, $\varepsilon = 0.73$, $\eta^2_{partial} = 0.73$, and PC, $F(2,32) = 7.5$, $p = 0.002$, $\varepsilon = 0.86$, $\eta^2_{partial} = 0.32$. The reduction of the congruency effect on RT under high time pressure was also replicated, $F(2,32) = 5.5$, $p = 0.009$, $\varepsilon = 0.97$, $\eta^2_{partial} = 0.25$. The congruency effect on PC under high time pressure, however, was not significant, $F(2,32) = 1.4$, $p = .27$, $\varepsilon = 0.88$, $\eta^2_{partial} = 0.08$, which contrasts with the results of Experiment 1.

For trials with a large interstimulus distance, time pressure again resulted in faster, $F(1,16) = 166.9$, $p < 0.001$, $\eta^2_{partial} = 0.91$, and less accurate responses, $F(1,16) = 121.8$, $p < 0.001$, $\eta^2_{partial} = 0.88$. The congruency effect was also replicated in both RT, $F(2,32) = 18.9$, $p < 0.001$, $\varepsilon = 0.89$, $\eta^2_{partial} = 0.54$, and PC, $F(2,32) = 23.8$, $p < 0.001$, $\varepsilon = 0.83$, $\eta^2_{partial} = 0.60$. Here, time pressure reduced the congruency effect on RT, $F(2,32) = 5.2$, $p = 0.011$, $\varepsilon = 0.97$, $\eta^2_{partial} = 0.24$, and increased the congruency effect on PC, $F(2,32) = 27.9$, $p < 0.001$, $\varepsilon = 0.75$, $\eta^2_{partial} = 0.64$, while such interactions were not observed in Experiment 2.

HDMM Parameter Estimates. Table 2 shows the mean estimated parameter values for α and v calculated from the posterior distribution after discarding the first 10,000 iterations to ensure that convergence had been met. The estimated values for α show a similar pattern as for Experiment 1 and 2, with a reduction of required evidence of 55% in the case of high time pressure relative to low time pressure, $t(16) = 10.1$, $p < 0.001$.

A repeated measures ANOVA on the estimated values of v with the factors interstimulus distance, congruency, and time pressure revealed the following results. The congruency effect, $F(2,32) = 74.0$, $p < 0.001$, $\varepsilon = 0.62$, $\eta^2_{partial} = 0.82$, and the effect of time pressure were replicated, $F(1,16) = 9.8$, $p = 0.006$, $\eta^2_{partial} = 0.38$. An interaction between time pressure and congruency was found, $F(2,32) = 9.5$, $p = 0.001$, $\varepsilon = 0.97$, $\eta^2_{partial} = 0.37$. A main effect of interstimulus distance was observed on v, $F(1,16) = 6.0$, $p = 0.026$, $\eta^2_{partial} = 0.27$, which reflected an overall higher drift rate with the large as compared to the small interstimulus distance. Interstimulus distance also modulated the interaction between time pressure and congruency $F(2, 32) = 5.0$, $p = 0.013$, $\varepsilon = 0.92$, $\eta^2_{partial} = 0.24$. Separate analyses for both distances showed that the interaction between time pressure and congruency on v was significant with the small interstimulus distance, $F(2,32) = 12.9$, $p < 0.001$, $\varepsilon = 0.92$, $\eta^2_{partial} = 0.45$, but not with the large interstimulus distance, $F(2,32) = 1.2$, $p = 0.326$, $\varepsilon = 0.99$, $\eta^2_{partial} = 0.07$. Specifically, in the case of the small interstimulus distance, the reduction of the drift rate due to time pressure was small for congruent trials but large for incongruent trials, while no such effect was present in the case of the large interstimulus distance.

C. Discussion

The main effects of time pressure and congruency as observed on our behavioral measures in Experiment 1 and 2 were replicated in our third experiment. A direct comparison of the results for the trials with a small interstimulus distance with the result of Experiment 1 shows a comparable pattern. However, the interaction between time pressure and congruency on PC did not reach significance in our third experiment. A direct comparison of the results for the trials with a large interstimulus distance with the results from Experiment 2 also showed some minor differences. In our third experiment, we observed a significant interaction between time pressure and congruency on both RT and PC that was not found in the second experiment. An examination of the estimated parameters for the drift rate and the response criterion might clarify whether these observed differences point to different conclusions.

Separate analyses of the estimated drift rate for both interstimulus distances revealed quite comparable effects of time pressure and congruency as in Experiment 1 and 2. Time pressure and congruency both affected the drift rate on trials with a small and large interstimulus distance. Importantly, time pressure increased the congruency effect for trials with a small interstimulus distance and did not influence the congruency effect for trials with a large interstimulus distance, which implies that the results on the drift rate as observed in Experiment 1 and 2 were replicated in our third experiment.

VI. General Discussion

In this paper, the central question to be addressed was whether tunnel vision, a shrinkage in the size of the attentional focus, can be demonstrated in the case of stressful conditions. To answer this question, we employed an arrowhead-version of the Eriksen flanker task, in which a central target was accompanied by congruent, neutral, or incongruent flankers. Stress was induced by varying time pressure between conditions. Three experiments were carried out in which different interstimulus distances were employed. Interest was focused on behavioral measures indicating possible effects of tunnel vision, and especially on parameters of the underlying decision process that can be estimated with the HDDM: the drift rate (ν), and the height of the response criterion (α). We expected to observe that increased time pressure would lead to a reduction of the response criterion, and that congruency of flankers would affect the drift rate, with the highest drift rate in the case of congruent flankers and the lowest drift rate in the case of incongruent flankers: a congruency effect. Most importantly, we reasoned that tunnel vision (in the case of high time pressure) would be reflected in a reduction of the congruency effect on the drift rate.

Behavioral results revealed clear effects of time pressure and flanker congruency in all our experiments. Responses were faster and less accurate when time pressure was high, demonstrating a speed-accuracy tradeoff. Responses were faster and more accurate in the case of congruent than in the case of incongruent flankers. However, the observed interactions between time pressure and congruency proved to be difficult to interpret as regularly opposite effects were observed on RT and PC. One of the major reasons to use the HDDM for our question of interest was to resolve this impasse.

The estimated parameters of the underlying decision process according to HDDM revealed several interesting insights. First, a consistent and expected observation was the reduction of the response criterion in the case of high as compared to low time pressure estimated on the basis of the behavioral results of our experiments. Secondly, we also consistently but unexpectedly observed a reduction of the drift rate in the case of high time pressure relative to the condition with low time pressure. Thus, time pressure reduced the response criterion but also decreased the rate of the accumulation of evidence. A possibility, considered more thoroughly below, is that the reduction of the response criterion may have been overestimated, which will thereby also affect the estimation of the drift rate. Third, we observed an interaction between time pressure and congruency on the drift rate for the conditions with the small interstimulus distance, but not for the conditions with a large interstimulus distance. Opposed to our expectations, this interaction in the case of a small interstimulus distance actually reflected a larger congruency effect in the case of high time pressure and not a reduction of the congruency effect. Thus, the influence of flankers on the accumulation of evidence was increased in the case of high time pressure, at least when interstimulus distance was not too large. These findings lead to the conclusion that time pressure did not induce tunnel vision but actually decreased the efficiency of attentional allocation, which is detrimental in the case of a small interstimulus distance but not so in the case of a larger interstimulus distance. Nevertheless, before accepting this as the conclusion of this paper it seems relevant to discuss four different issues. First, our results suggest that the presented conception of tunnel vision may simply be flawed, which may imply that we have to redefine what we precisely mean with the term tunnel vision. Secondly, according to some authors, the interpretation of the flanker effect has to be reconsidered, which has important consequences for the drawn conclusions. Third, the HDDM parameter estimates may not have been optimal, which consequently affects the interpretation of the observed effects. Finally, the generalizability of the results from our task to real life conditions may be questionable.

At the beginning of our paper, we indicated that tunnel vision may be understood as a shrinkage in the size of the attentional focus. This view is obviously based on a very literal interpretation of tunnel vision; may it not be the case that tunnel vision should be interpreted in a less literal and more metaphorical way? Of course, this all strongly relates to our view on spatial attention; can we really interpret attention as a spotlight, a zoom lens, or a gradient that varies in size? (e.g., see [15]-[17]). For example, it is becoming clearer that there are strong similarities between spatial attention and the retrieval of information from working memory (e.g., see [18]), and it seems according to several researchers in the field obvious that attention is not meant for perception but rather for interacting with the outer world. Maybe tunnel vision is better understood as a reduced ability to process all available information rather than a reduction in the size of the attentional focus.

A highly related issue concerns the interpretation of the Eriksen flanker effect. The common interpretation of the flanker effect is that participants are not able to consistently keep their attention focused on the central target but partly divide their attention across the flankers thereby invoking the benefit with congruent flankers and a cost with incongruent flankers. Recently, [19] proposed that the flanker effect does not emerge because of a failure in selecting the target from the array, in line with the aforementioned ideas, but rather as a consequence of the effectiveness of attentional selection concerning task-relevant features (for related discussions on the flanker task in terms of different variants of diffusion models, see [20]-[22]). Target-like features are simply extracted from the whole environment and not from a single location. If we extend this idea slightly further, this selection of target-like features may directly exert an effect on the selection of actions. In our task version, this implies the activation of conflicting actions in the case of incongruent flankers. Moreover, if we consider the earlier mentioned idea that time pressure also speeds up sensory processing by gain modulation (see [14]) then we might explain the presence of an enlarged congruency effect on the drift rate in our conditions with high time pressure as there will be a stronger activation of the two conflicting actions. The absence of this effect with the larger interstimulus distance may be ascribed to a reduction in the visual acuity of the flankers. Nevertheless, some other studies referred to in our introduction provided no support for an influence of time pressure on pre-motoric processes (see [3]; [5]). Furthermore, we did not find support for an increase in the drift rate on congruent trails, but mainly a decrease of the drift rate on incongruent trials. Nevertheless, it is obvious that other ideas concerning the origin of the flanker effect and attentional selection [19] have a major impact on the meaning of a phenomenon such as tunnel vision.

In all three experiments we noticed that time pressure not only reduced the estimated response criterion, but also reduced the estimated drift rate. The latter observation seems counterintuitive, as one might rather expect (see above) the drift rate to increase in the case of high time pressure. It may be argued that the estimation of the response criterion and the drift rate on the basis of HDDM are not completely appropriate. To evaluate this, we decided to use the estimated parameter values of Experiment 3 to reproduce the observed response data, which gives an idea of the goodness-of-fit of the obtained parameter values. Figure 4 shows the observed and predicted RT distributions for each condition for three participants, with incorrect responses flipped to the left. The gray bars represent the observed data, while the open bars represent the data generated by the estimated parameter values. The predicted data match the observed data quite well. Nevertheless, although the reconstruction of the response data suggests that the obtained parameter values are appropriate it is still possible that the HDDM overestimates the effect of time pressure on the response criterion. In all our experiments, the influence of high time pressure seems very strong, as a reduction of at least 45% was observed. If we consider the possibility that this reduction is an overestimation of the influence of time pressure (i.e., the estimate of α is too small), then an appropriate fit of the data can only be obtained if the effect on the drift rate is overestimated as well (i.e., the estimate of ν is too small), otherwise, the reconstructed response data should display shorter response data as compared to the originally observed data.

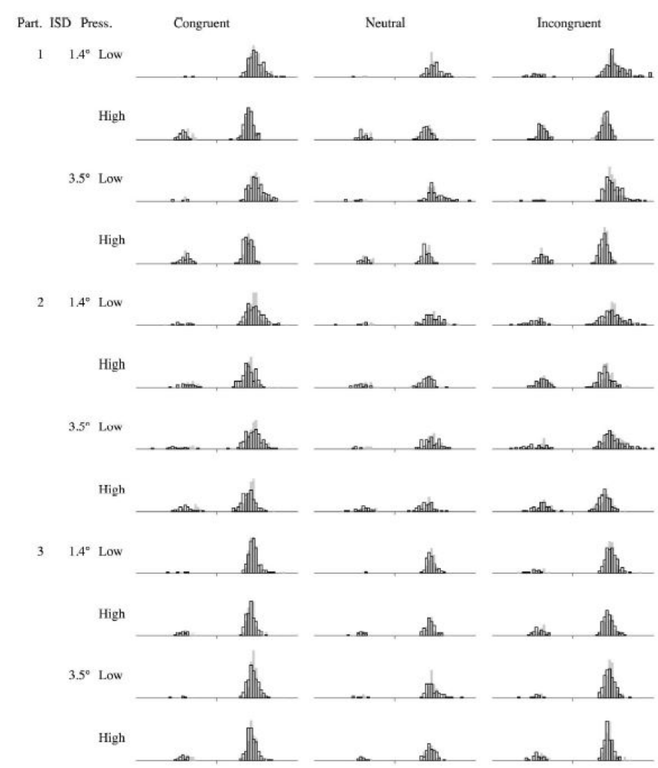

Fig. 4 Frequency histograms of observed and predicted behavioral data for the first three participants in Experiment 3. Part. =

participant, ISD = interstimulus distance, Press. = time pressure. The filled gray bars represent actual measured reaction times, divided into 50ms bins. The open bars represent the reaction times based on the estimated parameter values. The left half of each cell is a flipped histogram of the incorrect responses.

As we observed both a reduction in the response criterion and the drift rate due to high time pressure, this may very well have been the case. Moreover, earlier mentioned studies did not observe an effect of time pressure on pre-motoric processes [3],[5], which also seems not in line with an influence on the drift rate. Importantly, even though it may be the case that the reduction of the response criterion is overestimated, a possibly better estimation of the relevant parameters is likely to yield a comparable pattern of results.

Although the Eriksen flanker task used in this study seems well suited to test the presence of tunnel vision, its properties limit generalizability to other settings for several reasons. First, the stimuli that are to be ignored are always present on each trial. In real live settings such as in the car accident example in our introduction, stimuli outside the focus of attention are far from predictable. Second, in the flanker task the target is the only task-relevant stimulus while flankers are to be ignored. This categorization of stimuli as either task-relevant or task-irrelevant may also not generalize well to real-world settings as in the latter case every stimulus is potentially important.

On the basis of our behavioral data and the estimates of the underlying decision process determined by the HDDM it can be concluded that time pressure seems to lower the response criterion, while irrelevant flankers affect the speed of the accumulation of information. Opposed to our initial idea, it could not be concluded that time pressure induced tunnel vision, rather, it appears to be the case that time pressure reduced the efficiency of spatial attentional selection.

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