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Reply

An apparent compression cannot explain the difference between the original and the induced Roelofs effect

When a rectangular frame is presented with one of its edges on the subject's objective median plane, that edge is reported to be shifted to the side opposite to the rest of the frame (Roelofs, 1935). This effect is called the (original) Roelofs effect. When a target dot is presented within the same rectangular frame, an offset of the frame to one side of the subject's objective median plane causes a bias in the perceived target position in the opposite direction. This has been called the induced Roelofs effect (Bridgeman, Peery, & Anand, 1997). Both Roelofs effects could be caused by a perceived shift in straight-ahead. We rejected this hypothesis in a previous paper (De Grave, Brenner, & Smeets, 2002). Our main argument was that if our subjects did not know in advance what to report (position of frame or target), their responses showed a Roelofs effect for the frame, without an induced Roelofs effect for the target.

Dassonville and Bala (2004) question this conclusion. They assume that the original Roelofs effect contains two components: an apparent compression and a shift in straight-ahead. The apparent compression is a general phenomenon that applies to the target as well as the frame, and should be present regardless of the temporal order of the frame and the target. It could be a response bias or an error in converting the perceived position to a value in centimetres. Such an apparent compression is indeed evident in the target gains of our target estimation tasks (these gains do not equal 1). The other component is a shift in the perceived straight-ahead. As our data showed clear signs of apparent compression, we agree with Dassonville and Bala that this is a better framework to analyse our data. The question is: can we reject the hypothesis that the induced Roelofs effect and the shift component of the original Roelofs effect are both caused by the same shift in perceived straight-ahead? In other words, does our conclusion still hold if we take the apparent compression into account?

The effect of a combination of apparent compression and shift in straight-ahead can be formalised as follows: the estimated frame position (P_f') depends on a shift in perceived straight-ahead that is proportional to the frame position ($b_1 * P_f$) and a gain of the apparent compression of positions ($g * P_f$). It is assumed that the target position does not influence the estimated frame position (the mean gain of the influence of the target position on that of the frame was −0.01; see Table 1, 3rd column in De Grave et al. (2002)) The estimated target position (P_t') is determined by a shift in perceived straight-ahead ($b_2 * P_f$) and the same gain for the apparent compression of positions ($g * P_t$). Thus:

$$P_f' = (b_1 + g) * P_f + 0 * P_t \quad (1)$$

$$P_t' = b_2 * P_f + g * P_t \quad (2)$$

In the training session of our dual task experiment (De Grave et al., 2002), accurate feedback about the frame position was given. According to Dassonville and Bala (2004), this could have eliminated the shift in perceived straight-ahead ($b_1 = b_2 = 0$), without eliminating the apparent compression ($g < 1$). As the apparent compression is part of the original Roelofs effect, and not of the induced Roelofs effect, this might qualitatively explain our results. To test whether we can quantitatively explain our data with a single apparent compression g and a single (possibly zero) shift in straight-ahead $b_1 = b_2$, we will calculate both values for the shift in straight-ahead (b_1, b_2) from our data of the dual task experiment. Following the reasoning of Dassonville and Bala (2004), there should be no difference between our three orders of presentation. In order to have enough statistical power we will therefore average the data over these three conditions.

The first calculation is based on Eq. (2) alone. As explained above, the frame gain for the judgements of the target position (i.e. the induced Roelofs effect) is assumed to represent the shift in straight-ahead: $b_2 = 0.059$. For our estimate of b_1, we subtract the apparent compression g (obtained from the target gain for judgements of target position following Eq. (2)) from the frame gain of the frame judgements (the original Roelofs effect; ($b_1 + g$) in Eq. (1)). This yields a different value for the shift in straight-ahead: $b_1 = -0.095$. A paired t-test showed that $b_1 \neq b_2$ ($p < 0.01$), so we can reject the hypothesis of Dassonville and Bala (2004). Thus, also when taking into account the observed apparent compression, we can reject the hypothesis that the original Roelofs effect and the induced Roelofs effect are based on the same shift in straight-ahead.

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Response to Dassonville and Bala's (2004) comments

Dassonville and Bala originally suggested that the training preceding our dual task experiment eliminated both the original and the induced Roelofs effects. This suggestion is based on the assumption that there are two components to underestimating the eccentricity of a frame: a general underestimation of eccentricity (or overestimation of one's memory of what a centimeter looks like) and a shift in the perceived straight-ahead. Dassonville and Bala only consider the latter to be a true Roelofs effect (which in their view should not differ in magnitude from the induced Roelofs effect), and suggest that specifically this component is eliminated by our training of frame responses. What remains is a general underestimation of eccentricity, which is independent of the stimulus, so the temporal order in which target and frame are presented is irrelevant. Therefore we combined the data of our three conditions to test whether a general underestimation of eccentricity alone can explain our data, in which case we should have found that $b_1 = b_2 = 0$. The outcome of this test showed that $b_1 \neq b_2$, so they cannot both be zero, and the hypothesis of Dassonville and Bala could be rejected.

A shift in perceived straight-ahead would shift both the target and the frame to the same extent. If this shift is caused by the frame then the temporal order is probably important, so the way in which we combined the three conditions is not optimal, because it relies on the assumption that there is a shift that is independent of the temporal order. However, that does not explain why the assumed shift in straight-ahead differed significantly between the target and the frame (b_1 and b_2). Moreover, only considering conditions in which the target and frame were presented simultaneously would not lead to the conclusion that both effects were caused by the same mechanism. The difference is not significant at the 5% level, but it is at the 9% level, so that is not enough to conclude that they are the same.

It is also not at all clear how the feedback that was provided during training in the dual task could have made subjects overcompensate for the induced Roelofs effect, as Dassonville and Bala propose. Subjects never received feedback about the induced Roelofs effect, because training was always separate for the target and the frame. The training can lead to a change in strategy such as learning to ignore the frame's position when estimating straight-ahead. Although this could eliminate the shift, it cannot lead to overcompensation.

Since we obviously cannot know the frame gain for the frame judgement in the single task, because there can be no frame judgements in the single task, we should remember that Dassonville and Bala's suggestion that this gain is fundamentally different from that in the dual task is still only a hypothesis. If it is not true, all our original conclusions are valid. If it is true, we still cannot explain all the findings, because generally underestimating eccentricity is not enough. Any alternative mechanism that one introduces to explain the interaction between target and frame in the dual task experiment would justify our conclusion that the original and induced Roelofs effects are not (only) caused by a common mislocalisation of straight-ahead as the original Roelofs effect.

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