Reviewer's report

Title: Leg orientation as an indicator of perceived body orientation in stroke patients

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Reviewer: Stefan Glasauer

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General

The present study investigates leg posture while sitting in stroke patients with pusher syndrome and compares it with that of three groups of control subjects. In comparison to the controls, the non-paretic leg of pusher patients shows an ipsiversive tilt of about 10° with respect to the trunk, which was almost independent of trunk orientation in roll. The authors conclude that spontaneous leg orientation in pusher patients corresponds to their disordered perception of body orientation, and that leg-to-trunk posture may be used as a clinical bedside tool for the detection of pusher syndrome.

The study is clearly written, the inclusion of three groups of control subjects is of special interest also for a wider audience, but there are a number of problems outlined below which should be addressed before publication. Especially, the conclusion that leg orientation reflects perceived body orientation is, in my opinion, too strong.

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Major Compulsory Revisions (that the author must respond to before a decision on publication can be reached)

Leg orientation as indicator of body orientation: from the finding that pusher patients show about 10° of leg tilt at upright position, and that control subjects show the same leg tilt at about 20° trunk tilt, the authors infer that pusher patients feel tilted by about 20°. This conclusion is, in my opinion, not valid. The authors note themselves that pusher patients expressed a stiffened response of their non-paretic leg by keeping their leg almost in a constant orientation with respect to the trunk. Such an almost constant leg-to-trunk orientation is not found in control subjects. Therefore, the leg orientation of pushers does not correspond to perceived body orientation in the same way as in controls, and the authors’ conclusion is invalid.

A direct comparison with perceived body orientation in the present patient population, if resulting in a correlation, would strengthen the authors’ conclusion, but is missing, which is a weakness of the present study.

Therefore, I suggest to change the title (e.g., leg orientation as clinical sign for pusher syndrome) and reformulate the conclusions.

Results: while the average leg-to-trunk orientation of pushers was different from that of other groups, the intercept of the regression was not. This is difficult to understand, since, assuming a linear relation of trunk vs. leg and equal tilts to both sides, both parameters should actually be the same. My concern is that the average leg-to-trunk orientation of pushers is biased by a difference in ipsi- vs. contralateral trunk tilt. This parameter is not presented in the analysis of passive trunk tilt, but it is very important to understand the results. It should therefore by investigated. A possible circumvention of unequal tilt ranges is to limit the analysis of averages to a smaller range of tilts which has been reached by all subjects on each side.

Postural response and perceived body orientation: the authors seem to assume implicitly that postural responses correspond to perceived body orientation. This, however, is not true in general. Consider standing in a rapidly accelerating train or bus: one exhibits strong postural responses to maintain balance even though the perceived body orientation is not affected. This example shows that postural responses may reflect movements of the support surface rather than changes in perceived body orientation.

Vestibular patients: what is completely missing is why the vestibular patients were included in the study. I think that comparison to this group is very interesting, but the authors should discuss the effects of acute unilateral failure on perceived orientation and posture. As the authors know quite well, and there is quite some literature on the topic, those patients show a deviation of the subjective visual vertical and a falling tendency, i.e., both their perceived body orientation and their postural responses are affected by the lesion. The results shown here demonstrate that disturbed vestibular afferent information apparently does not
affect leg posture while sitting, which is an interesting finding in itself. Therefore, the situation in pusher patients must be different. The authors’ conclusion is but one possibility. For example, pusher patients may suffer from disturbed vestibular information that cannot be suppressed for spontaneous leg adjustment.

Discussion (page 9) about bilateral vestibular deafferentation: Instead of discussing in length bilateral vestibular failure, it would be more appropriate to consider unilateral vestibular failure.

Healthy controls: Fig. 2 shows that NBD controls fall into two groups. This deserves some comment, since the regression only gives a very crude picture of the real situation. Was this different behaviour somehow linked to the fact that the experimenter always sat on the left side?

Data analysis and Results: the introduction of the velocity gain is not clear to me. It seems that velocity gain is confounded with tilt gain, i.e., with the gain of leg vs. trunk orientation which corresponds to the slope of the regression line. Velocity gain may differ from that, for example, if the leg lags temporally behind the trunk. Specifically, on page 7, the authors write: “pusher patients also demonstrated a slightly steeper slope of the linear regression of the leg orientation as a function of trunk tilt. Figure 3b thus illustrates the average velocity gain of leg and trunk movement for all subject groups.” Why thus illustrates? The steeper slope of the regression is the parameter of interest, while the velocity gain is difficult to interpret without knowing about the dynamics of leg adjustment.

Figure 4: difficult to understand (for example, there is no x-axis), I recommend to either change the figure or omit it.

Minor Essential Revisions (such as missing labels on figures, or the wrong use of a term, which the author can be trusted to correct)

Page 6, 1st paragraph: “A gain of 1 indicated perfect correspondence between the movement of the head or the leg relative to the trunk movement.” Not correct, the gain computed here tells only about the relation between maximal leg and trunk velocity, but both movements may be different otherwise.

Page 6, 2nd paragraph: Delete the sentence “We thus averaged each variable over both viewing conditions.” Apparently, this was not done, and should not be done, since the interaction group x viewing condition became significant for one of the variables.

Page 8, 2nd paragraph: “with closed eyes 1.08 (SD 0.29) compared to open eyes 1.01 (SD 0.29) for all four groups”: Brackets around gain values missing.

Page 9, 2nd paragraph: “Thus, a good correspondance exists between …”: This correspondence only exists if assuming that the conclusion is correct (see above), and that all patients show that same average perceived tilt.

Page 9, 2nd paragraph: “both measures obviously accured accidentally”: occurred

Page 9, 2nd paragraph: “but implies that in pusher patients a representation …”: better: “better suggests that …” The present findings do not really imply this conclusion. This should be changed at several occasions in the text.

Page 10, 1st paragraph: “This result proves that disturbed vestibular afferences are not responsible for … better: This result proves that disturbed vestibular afferences alone are not responsible for the …”

Page 10, end of 2nd paragraph: “dependent on leg proprioception itself but”: proprioception

Figure 2, caption: “The broken thick line indicates the group’s averaged linear regression.” Line computed from average regression parameters?

Discretionary Revisions (which the author can choose to ignore)

Fig. 2: One of the patients showed a very different behaviour, even though I suppose that his pushing behaviour and perceived body orientation was not too much different from the other patients. At least in this
patient, a simple bedside evaluation of leg-to-trunk posture would fail.

**What next?:** Unable to decide on acceptance or rejection until the authors have responded to the major compulsory revisions

**Level of interest:** An article whose findings are important to those with closely related research interests

**Quality of written English:** Acceptable

**Statistical review:** No

**Declaration of competing interests:**

I declare that I have no competing interests.