

## Comprehensive report

First and last name of the doctoral candidate: Najib ABI CHEBEL

First and last name of the thesis supervisor: Fabrice SARLEGNA and Christophe BOURDIN

Title of the thesis: Specificity of proprioceptive perception across joints and arms in sighted and blind adults

***NB. The criteria under the three headings are indicative and non-exhaustive; they are not necessarily relevant in all cases.***

1. *Synthetic presentation of the thesis, in particular its context (research unit(s), interdisciplinary nature, socio-economic or other partnership ...) and its content (indicate for example the number of pages, annexes, overall structure, hypotheses, main results etc.).*

This thesis is a 193-page document with an introduction and state of the art of 56 pages, a 3-page section on methods - common to all contributions -; then three studies (accepted or in prep publications) of 20 to 30 pages each. It ends with a general discussion, some perspectives (3 pages) and a list of references. The document is clear and well organized. The figures are well made and illustrate the point well.

I appreciated the short summary at the end and of each section which allows to clearly understand the take-home message related to each section.

The problem statement of the thesis lies in the influence of the arm segment (elbow or shoulder) on the precision and accuracy of proprioception, as well as the impact of visual impairment on both accuracy and precision.

In the first study, Chebel, with his collaborators, has shown that proprioception accuracy and precision, evaluated with an ipsilateral passive matching task with sighted blindfolded individuals, is specific to both the side (left vs. right) and joint (elbow vs. wrist) of the arm.

In the second study, they assessed proprioception accuracy and precision in a group of congenitally blind subjects and compared their performance to an age- and sex-matched group of blindfolded-sighted participants. They showed that the absence of visual experience may alter the proprioception precision but not the accuracy, in line with the general-loss hypothesis (Cappagli et al., 2015).

In the third study, they tested the hypothesis that the proprioception accuracy is enhanced in blind people with residual vision as compared to totally blind and sighted individuals. They also show that visual experience influences the lateralization of proprioception accuracy.

In these three studies, the methods and results are clearly described, and the discussions are convincing. Both Study 1 and 2 have been published in selective international journals. Study 3 is under preparation.

The general discussion (7 pages) is interesting and well organized. I appreciated the introduction of Bayesian models to better illustrate the results.

2. *Scientific expertise of the work: evaluate, for example, the degree of originality (innovation, advances in relation to the state of the art, contribution to the advancement of knowledge), the methodological contributions (originality of the method, rigour in the analysis of the data, objects or situations studied, rigour of the argumentation), the scope of the work carried out (complexity, extent of the research, quality of the results obtained), the candidate's abilities (critical analysis, synthesis, scientific maturity, ability to put the results into perspective), the valorisation of the work, etc. Indicate the points that may give rise to discussion during the defence.*

This PhD thesis undoubtedly meets the international standards. Reading it allowed me to delve with interest into the problem of the impact of visual impairments on proprioception. The thesis is well written and well-structured. The methods are rigorous and convincing, and the different experimental results contribute to a better understanding of this research field. The provided quotes and discussions on sensory compensation are relevant.

The PhD defense will be an opportunity to discuss with the candidate the alternative explanations for the observed results, i.e. the potential effects related to education, training (see e.g. Cuppone et al 2019), or more cognitive haptic encoding strategies (see e.g. Picard et al 2010 and Lebaz et al 2012). Finally, I think that the impact of visual impairments on the Body Schema (De Vignemont 2010) should also be discussed.

In addition, M Chebel states that: "Given the influence of vision on proprioception, the findings of our study may inform rehabilitation and training approaches for blind and sighted individuals" (p160). I would also like to discuss what is being suggested here and whether it relates to my previous comment.

3. *Formal expertise of the thesis manuscript: evaluate, for example, the structuring of thoughts, the quality of the writing (clarity and correctness of expression), the material presentation (footnotes, quotations, titles and subtitles, internal references, etc.), the management of the bibliography (relevance of the bibliographical references, adherence to presentation norms), the quality of the figures and tables, etc.*

There are a few minor points that I would like to see improved in the document:

The first concerns the terms used regarding groups of subjects with visual impairments. I absolutely agree that the term "blind" can refer to subjects who are legally blind but with residual visual perception. In order to avoid any ambiguity when reading, I suggest indicating it precisely throughout the document (e.g. "blind with residual vision" vs "totally blind"). Likewise, common terms such as "Early blind" or "Late blind" should be used systematically. Of course, this does not prevent from specifying the duration of the absence of vision or the proportion of life without vision (as was initially proposed by Lebaz et al in 2010). This careful task would be an opportunity to be more precise when citing references, particularly in the introduction. For illustration purpose, the terms "early vision" and "lifelong vision" are sometimes used interchangeably in study 2. A glossary added to the document could possibly include all the terms to be used accurately throughout the document.

I would also suggest to better rely on existing definitions regarding "accuracy" and "precision". If I'm correct, the terms "error" and "variable error" are used instead of "accuracy" and "precision" that have been previously defined (see <sup>1</sup>) and that are used in many fields of experimental and behavioral psychology (see the eye movements field for instance). Using them may help to be more rigorous and explicit in the document.

Study 3 is presented according to an unconventional outline, with the materials and methods following the results. I understand that this format is that of the targeted journal, but I think that it would be more appropriate to respect the regular format in the thesis

I also wonder if the cited references can remain at the end of each study or should be moved to the end of the document.

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<sup>1</sup> [https://en.wikipedia.org/wiki/Accuracy\\_and\\_precision](https://en.wikipedia.org/wiki/Accuracy_and_precision)

#### References

Cuppone, A. V., Cappagli, G., & Gori, M. (2019). Audio-motor training enhances auditory and proprioceptive functions in the blind adult. *Frontiers in neuroscience*, 13, 1272.

S Lebaz, C Jouffrais, D Picard (2012). Haptic identification of raised-line drawings: high visuospatial imagers outperform low visuospatial imagers. *Psychological research*, 1-9

Lebaz, S., Picard, D., & Jouffrais, C. (2010). Haptic recognition of non-figurative tactile pictures in the blind: does life-time proportion without visual experience matter?. In *Haptics: Generating and Perceiving Tangible Sensations: International Conference, EuroHaptics 2010, Amsterdam, July 8-10, 2010. Proceedings* (pp. 412-417). Springer Berlin Heidelberg.

D Picard, S Lebaz, C Jouffrais, C Monnier (2010). Haptic recognition of two-dimensional raised-line patterns by early-blind, late-blind, and blindfolded sighted adults *Perception* 39 (2), 224

De Vignemont, F. (2010). Body schema and body image—Pros and cons. *Neuropsychologia*, 48(3), 669-680.

#### 4. Conclusion:

In conclusion, I consider that this work definitely meets the international requirements for defending a doctoral thesis and I authorize the defence.

It will be a nice opportunity to discuss interesting scientific questions with M Chebel who is now an expert in the field.

#### 5. If relevant, list the corrections requested here :

- Terms related to visual impairments.
- Terms related to accuracy and precision.
- Structure Study 3 in the document.
- Better discussion and/or perspectives on alternative explanations (training and encoding strategies), and add related references.

First and last name of the reviewer: Christophe Jouffrais

Date: 28/11/2023

Signature of the reviewer:



Cadre réservé à l'Administration

Avis du directeur / de la directrice de l'École Doctorale

- ☐ Accepté
- ☐ Accepté avec corrections ponctuelles (corrections remises le jour de la soutenance)
- ☐ Je demande le report de la soutenance pour révision complète du manuscrit.