*Cover letter instructions (from eNeuro on registered reports)*

* *A brief scientific case for consideration. Authors are encouraged to refer to the likely replication value of the research. High-value replication studies are welcome in addition to novel studies.*
* *A statement confirming that all necessary support (e.g. funding, facilities) and approvals (e.g. ethics) are in place for the proposed research. Note that manuscripts will be generally considered only for studies that are able to commence immediately; however authors with alternative plans are encouraged to contact the central office for advice (*[*eNeuro@sfn.org*](mailto:eNeuro@sfn.org)*).*
* *An anticipated timeline for completing the study if the initial submission is accepted.*
* *A statement confirming that the authors agree to share their raw data, any digital study materials, and laboratory log for all published results.*
* *A statement confirming that, following IPA, the authors agree to register their approved protocol on the Open Science Framework or other recognized repository, either publicly or under private embargo until submission of the Stage 2 manuscript.*
* *A statement confirming that if the authors later withdraw their paper, they agree to the Journal publishing a short summary of the pre-registered study under a section Withdrawn Registrations*

Date

Dear Editor,

We are submitting the Registered Report, **“The role of movement consistency in locomotor use-dependent learning”**, to be considered for publication in *eNeuro*.

Repetition is an essential component of practice to acquire new skills. Yet, even after skills are acquired, repetition can continue to improve movement patterns. Repetition based learning, referred to as use-dependent learning, biases future movements to be more like the repeated prior movements. Use-dependent learning has almost exclusively been studied in reaching movements despite the fact that reaching movements are discrete, require one repetition to complete a goal, and are planned and specified prior to movement initiation.

Walking, on the other hand is, by definition, a repetitive, cyclical movement which must be repeated until a destination is reached. This provides an excellent opportunity to study use-dependent learning. There has only been one prior study which has examined use-dependent learning in walking from a mechanistic perspective (Wood et al., 2020). This study found that use-dependent learning explains step asymmetry aftereffects in visually guided walking, not sensory prediction errors as was speculated in prior literature (Cherry-Allen et al., 2018; French et al., 2018; Hussain et al., 2013; Kim and Krebs, 2012; Kim and Mugisha, 2014; Statton et al., 2016; Wood et al., 2020). In this study, participants changed their stepping asymmetry in response to visual targets on a computer screen causing them to walk with a limp. This pattern of walking was repeated and when the participants were asked to return to normal walking without any visual feedback, the limp persisted indicating use-dependent learning took place.

A defining trait of use-dependent learning is that the repeated movement pattern requires some level of stability to induce a use-dependent bias. Meaning that the movements must be similar to one another. However, not all movements are the same. Therefore, we seek to test two competing computational models against empirical data to determine the constraints of environmental consistency on the use-dependent learning mechanism. This approach will also provide the first computational account of use-dependent learning in walking. Since there are no computational models of use-dependent learning in walking, we adapted two different models from upper extremity studies (Diedrichsen et al., 2010; Verstynen and Sabes, 2011).

In the proposed study, we will manipulate the consistency of step asymmetry targets during learning to observe the impact on use-dependent bias. We will then compare these empirical results to using two computational accounts which make distinct predictions regarding the impact of target consistency on use-dependent bias. The Adaptive Bayesian model accounts for the consistency of targets by combining prior target information with current target information. Thus, the more consistent the targets the greater the bias. The Strategy plus UDP model uses large strategic corrections to hit the target while a low-level use-dependent bias develops in the direction of the step asymmetry. This model does not account for the consistency of targets.

The proposed study offers both novelty and replication value. The novelty is in a computational approach to use-dependent learning in a walking task as opposed to a reaching task. Our study will also determine which of the two distinct computational accounts of use-dependent learning is more likely. The proposed study could also be viewed as replication of the study which developed the Adaptive Bayesian model (Verstynen and Sabes, 2011) which found that consistency of targets is an important component of use-dependent learning. The major difference being the proposed study is in walking not reaching.

We currently have approval from the University of Delaware Institutional Review Board to perform this work. We furthermore have the facilities and funding to complete the work. However, all labs have been shut down due to the COVID-19 pandemic. Data collections are ready to be initiated as soon as human research resumes at the university. Given uncertainty around when labs will be reopened, we offer a proposed resubmission window from November 15th, 2020 to May 15th, 2021.

All authors agree to share the raw data, any digital study materials and laboratory log for all published results. We will also register the protocol on the Open Science Framework regardless of our acceptance here. If we later withdraw this paper, we agree to eNeuro publishing a short summary of the pre-registered study under the Withdrawn Registration section.

We look forward to your assessment.

Sincerely,

Jonathan Wood, Susanne Morton and Hyosub Kim