Planning and updating of response movement by accumulated decision evidence

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Acting in the natural world requires not only deciding among multiple options but also converting decisions into motor commands. The link between the dynamics of decision formation and the response movement and which brain areas are involved in it remains poorly understood. Here we investigate how the accumulation of decision evidence shapes the response orienting trajectories in a task where freely-moving rats combine prior expectations and auditory information to select between two possible options. Response trajectories and their motor vigor are initially determined by the prior. Rats movements then incorporate sensory information as early as 60 ms after stimulus onset by accelerating or slowing depending on how much the stimulus supports their initial choice. When the stimulus evidence is in strong contradiction, rats change their mind and reverse their initial trajectory. We encapsulate this plan-initiate-and-update behavior in a computational model that, by mapping the decision variable onto the movement kinematics at discrete time points, captures subjects' choices, trajectories and changes of mind. We tested the predictions of the model by photo-suppressing the dorso-medial striatum (DMS) at different trial epochs. DMS inactivation before the stimulus presentation caused a reduction of the impact of the prior —but not the stimulus— on choice. In contrast, inactivation during the stimulus period caused a strong reduction of the stimulus impact and a weak decrease of that of the prior. In summary, we show that motor responses are not ballistic but, instead, are systematically and rapidly updated. Furthermore, our results suggest that the DMS encodes the decision variable that integrates both the prior and stimulus evidence and guides subsequent behavior, as proposed by our model.