transfer entropy from channel *A* to channel *B* measures how well the future state of channel B can be predicted knowing the current state of channel A (see (Schmidt et al. 2013) for details).

First, we wanted to investigate the “sensorimotor structure”, i.e. the relative strengths of relationships between different sensors and motors, which is intrinsic to the robot’s embodiment (body + sensor morphology only). To this end, random motor commands were applied and the relationships between motor and sensory variables were studied, closely resembling the notion of SM environment (Bührmann et al. 2013). The strongest information flows between pairs of channels were extracted and are shown overlaid over the schematic of the Puppy robot (dashed lines) in panel **(B)**. The transfer entropy is encoded as thickness and gray level of the arrows. The strongest flow occurs from the motor signals to their respective hip joint angles, which is clear because the motors directly drive the respective hip joints. The motors have a smaller influence on the knee angles (stronger in the hind legs) and on the feet pressure sensors – on the respective legs where the motor is mounted, thus illustrating that body topology was successfully extracted (at the same time, the flows form the hind leg motors and hips to the front knees highlight that the functional relationships are different than the static body structure; see also (Schatz and Oudeyer 2009)). These patterns are analogous to the modality-related SMCs; just as we can predict what will be the sensory changes induced by moving the head, the robot can predict the effects of moving the hind leg, say.

In a second step, we studied the relationships in the sensorimotor space when the robot was running with specific coordinated periodic movement patterns or gaits. The results for two selected gaits – turn left and bound right[4] – are shown in panels **(C)** and **(D)**, respectively. The flows from motors to the hip joints, which would again dominate, were left out from the visualization. The plots clearly demonstrate the important effect of specific action patterns in two ways. First, they markedly differ from the random motor command situation: the dominant flows are different and, in addition, the magnitude of the information flows is bigger (the number of bits – note the different range of the color bar compared to **(B)**), illustrating how much information structure is induced by the “neural pattern generator”. Second, they also significantly differ between themselves. The “turn left” gait in panel **(C)** reveals the dominant action of the right leg and in particular the knee joint. In the bound right gait in **(D)**, the motor signals are predictive of the sensory stimulation in the hind knees and also the left foot. The gaits were obtained by optimizing the robot's performance for speed or for turning and thus correspond to patterns that are functionally relevant for the robot and can even be said to carry “value”. Thus, in the perspective of (Bührmann et al. 2013), our findings about the sensorimotor space using the gaits can be interpreted as studying the SM coordination or even SM strategy of the quadruped robot.

Finally, next to the embodiment or morphology (shape of the body and limbs, type and placement of sensors and effectors, etc.) and the brain (the neural dynamics responsible for generating the

[4] “Turn left” was a movement pattern dominated by the action of the right hind leg that was pushing the robot forward and left. Regarding “bound right”, bounding gait is a running gait used by small mammals. It is similar to gallop and features a flight phase, but is characterized by synchronous action of every pair of legs. However, in this study, we used lower speeds, without an aerial phase. In addition, the symmetry of the motor signals was slightly disrupted, resulting in a right-turning motion.