Sculpting the space of actions: explaining human action by integrating intentions and mechanisms

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This part started with the example of a whining and babbling baby that increasingly gains control over its voice and subsequently over linguistic and musical structures that eventually enable it to sing. We analyzed this trajectory of development and learning as a process in which kludges are formed that modify the mechanisms responsible for the child's functions. Building on insights from chapter I.5, this analysis should convince the reader of the fact that mechanisms which are used to explain cognition and behavior are highly dynamic and modifiable. Involving structural modifications as a result of development and learning, these mechanisms can obtain novel properties and capabilities. The phenomenon of a child who quickly learns to control complex functions and in a short time acquires many completely novel capabilities already supports this modifiability. It was confirmed once more at the end of chapter II.4, when we met the hybrid phenomenon of extended cognition, with biological brains effortlessly co-opting contemporary technologies. The latter phenomenon, however, emphasized another issue that we already observed along the way.

Mastering a skill or gaining expertise in any cognitive or behavioral function corresponds with a process of kludge formation, affecting the action space of these functions, so we argued. Some linguistic structures will be better mastered than others, some melodies sung automatically while others still require attention of the singer. Moreover, we also observed that such an action space pertaining to a function is not well-defined but can be expanded, covering areas that were previously separate. Indeed, the action spaces of previously distinct functions can become strongly associated or to some extent integrated thanks to the processes discussed here. Modularization of a particular neural network, for example, corresponding to development and learning of a specific skill, facilitates their activation, restricts the recruitment of necessary neural resources and diminishes influences from other neural networks. As a result, the demands on the brain decrease when the skill needs to be performed. Importantly, this not only leaves extra room for simultaneous performance of other cognitive or behavioral functions, it also facilitates the further development, elaboration and expansion of that particular skill. The child, for instance, may not just master the distinct skills of voice control, rhythm control, syntax and semantics, but could eventually integrate these skills enough to become an opera singer. With many routines being developed, some covering a highly general and others a more specific domain, this child's responsible mechanisms have become ever more complex. This complexity is due to its simultaneously establishing ever more kludges and to the fact that some of these become strongly associated, perhaps even merging into a single, complex kludge.

As is generally the case in cognitive neuroscientific explanations, developments like these can be described at different levels of analysis or from different theoretical perspectives. In Part I we argued that both Marr's three levels of analysis as well as levels of mechanism would need to be taken into account for a comprehensive explanation of cognition and behavior. In both cases the notion of representation is useful, for example when an explanation of information processing is at stake or when we aim to explain how a particular motor action is modified, expanded, or the like. For our purposes, we especially made use of the notion of representation to clarify that kludge formation is not just a modification of processes going on in an isolated brain. On the contrary, so we argued, learning and development occur in continuous interaction with bodily processes, that also affect in specific ways the modifying brain processes, including the kludges that are established. Moreover, information pertaining to properties of the environment plays a role in these modifications and kludges. In some sense, then, environmental information becomes represented in the relevant action spaces – facilitating the interaction with specific environments, enabling greater speed and flexibility in responding to particular environmental stimuli.

A further observation concerned the fact that this entrenchment of environmental information in modifiable mechanisms and in kludges can have far-reaching consequences. Given the fact that a snowball effect occurs when a particular cognitive or behavioral process becomes automatized due to kludge formation, the entrenched information will affect subsequently activated processes as well. Cultural peculiarities in tone formation or pitch in speech, for example, will continue to influence a novice's singing. Only by paying due attention to this and with careful training – that is, by recruiting extra resources – may an expert regain control of such basic vocal functions and add different kinds of tone formation to his vocal palette. In so doing, he aims to establish more than a single kludge so that he can sing in different vocal modes. Indeed, when an expert singer has established kludges for several components of the mechanism involved for vocal control, it becomes easier for him to focus on the more subtle differences that characterize German or Italian. Although his singing is largely automatized, this does not preclude the expert's capability of having access to those subtleties that he normally would not pay attention to. The representation of environmental information in such capabilities and their development can apparently have very different forms and allow different modes of access. Still, even the representation of highly complex information, like mathematical structures or difficult atonal opera lines, can be involved in kludge formation and affect several interrelated cognitive and behavioral functions.

A final point that merits attention in this concluding chapter of Part II, as it will reappear in the third and last part, concerns the complex and composite nature of the representations involved in most cognitive and behavioral processes. The composability of words, sentences and stories is not something unique to human language, but has analogies in action and cognition, too. Indeed, this similarity in composability or configurability of the representations and activities involved in cognition, language and motor action is supported by mechanisms in the brain and rely on the modifiability of mechanisms which are not completely specific to humans. Irrespective of this fact, we found that particularly in humans there is an immense space of options available for such configuration of actions, for example. Since actions are not represented as single units but rather as composed of different components represented in a distributed way in neural networks, agents can form novel actions even without learning new components by reconfiguring familiar actions. The human brain, characterized among other things by its large prefrontal cortex, is particularly well-equipped for the representations necessary for complex action and cognition. Facilitated by kludge formation that may include particular components of well-learnt actions, an opera singer may in addition to his singing easily learn to accompany his singing with fencing with his sword or dancing with his beloved – a combination of actions that is far beyond the reach of a novice. Indeed, the complex and distributed representations involved in such complex actions offer many potential points of contact with external objects or persons that have to play a role in these actions. The configuration of an action can include an object as a component for which to prepare a specific manual grasping movement, as an instrument for hitting a particular structure, or even as the final goal of a particular sequence of actions. Depending on where such an object figures in the complex action, an agent needs to take into account its particular properties and integrate them in his action representation. Fortunately, again, such interaction can also become facilitated by kludge formation with the integration of relevant environmental information.

Having articulated these main lessons from Part II, we can now take the next and final step. Inspired by Aristotle's comparison between moral action and musical activities and with our insights from Part I, we will reflect upon complex intentional action – including actions that are subject to moral requirements. This comparison invites questions concerning the requirements for complex action, particularly complex moral action. Do we not always expect moral action to depend upon complex and conscious decisions or intentions, making them very different from the automatized actions of a musician or singer? Indeed, is automatization not at odds with the adaptivity and flexibility that we usually associate with morally adequate action? Or does automatization rule out the accountability and responsibility for automatized actions, even though these are crucial features of human interactions? In sum, is the concept of a sculpted action space due to kludge formation at all applicable to intentional and moral actions, as we tend to associate such actions with unique decisions that take into account multiple kinds of information and can therefore not even partly be automatized? As may be expected from the foregoing, our argument will belie these assumptions. Don't we expect from an expert singer both a nuanced and moving interpretation of a dramatic area and the capability to effortlessly respond to the conductor's and director's desires and the whims of his partners on the stage? Aren't we capable of recognizing his personal style in his performances, while still admiring his flexibility in adapting to the different contexts an expert has to deal with? Apparently, the singer is able to flexibly configure his complex behavior and differentially integrate environmental influences in it while still keeping to some of his personal long-term commitments and intentions. It is this fascinating phenomenon that will occupy us from now on.