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

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1 INTRODUCTION: A COMMON CAPABILITY WITH DIVERGENT RESULTS*

The extent to which humans are capable of performing highly complex and socio-culturally influenced cognition and action in a seemingly effortless way remains remarkable. Ranging from motor behavior like cycling or swimming, through the use of musical or surgical instruments, up to the concentrated efforts in social actions like acting on stage or the battlefield, humans perform these actions as if they have come completely naturally. The ease and speed with which experienced performers are capable of learning and adjusting their actions enhances this apparent naturalness. This appearance, however, conceals the efforts, attention and time that were invested before such results could be reached. A way of describing these results is to observe that humans are capable of ‘sculpting their space of actions’. The limitations on the available ‘space of actions’ are hard to define in a general sense. Interestingly, it turns out to be malleable along several dimensions: the most obvious is that it can be expanded by including ever more types of action in it through learning and practice. A second dimension is the transformation of existing contents of the action space due to learning and practice, leading to astonishing differences in the performances of similar actions by experienced versus non-experienced individuals. Even for actions that stem from a rather common domain, the effects of the process of sculpting are clearly visible. As we will see in this dissertation, this sculpting relies on a wide variety of processes, ranging from automatization through endless repetition without much cognitive effort, to conscious control of specific components of the action.

To be sure, the phenomenon of different processes contributing to action has long received attention from scientists and philosophers. It is akin, for example, to Aristotle’s reflection on our ability to habituate virtuous action in his *Ethica Nicomachea* and *Politics*. At first, Aristotle appears to determine only a single cause of action when he states that ‘prohairesis’ or deliberate choice is the principle of action (*Ethica Nicomachea* 1139 a 31). However, he continues with the observation that there is also a final cause involved and that “desire and reasoning with a view to an end” are at the origin of the choice (*Eth. Nic.* 1139 a 33). In fact, Aristotle elsewhere points out that there are at least seven causes determining human action, as he lists “chance, nature, compulsion, habit, reasoning, anger, or appetite” (*Rhetorics* 1369 a 5-6). Similarly, the moral excellence of a person depends on such causal plurality which includes not just deliberate choice, but also nature and habit (Murphy 2002). Indeed,

* On pages 371, 373, and 375, figures I, II, and III offer simplified representations related to the arguments made in Parts I, II, and III respectively. Figure I is particularly relevant as a representation of the main contents of section I.5.

such juxtaposition of causes has enabled man, the “animal who has the gift of speech” (Politics 1253 a 9-10), to develop not just his individual moral excellence but also to develop collectively the polis which subsequently influenced human flourishing.¹³

A plurality of causes is not specific to a distinctive and intricate phenomenon like virtuous action. In several places, Aristotle compares the effects of practicing music with the effects of learning to act virtuously and then concludes that in both cases it is the formation of dispositions that is crucial (Woerther 2008). Moreover, he states that the word for development of excellent moral functioning stems from the word that refers to habit (ethos): “ἡ δ’ ἠθικὴ ἐξ ἔθους περιγίνεται” (Eth. Nic. 1103 a 17). Similarly for music, even though we depend on a natural disposition for habits to form, it is only after learning and practice that we may excel in an activity like playing the zither (Eth. Nic. 1103 a 35). In this dissertation, we will follow Aristotle and analyze some of the processes involved in human action, particularly intentional action while illustrating our analysis now and then with the example of an expert singer. Both in intentional action and in singing, we will find, a comparable plurality of causes and processes is at work. In many respects these converge in producing particular results, yet in other respects they seem to yield divergent and sometimes even counterproductive results. Since the example of musical performance does not involve difficult ethical issues associated with moral action, the complexity of explaining musical performance is easier to demonstrate. Before starting the discussion of four different methodological proposals regarding such explanatory work, which makes up this part, let us give a first impression of the complexity of explaining musical performance as it offers a glimpse of some of the issues treated in this book.

It appears that the human capability for music and particularly for singing is observable in all parts of the world and in humans from all ages and perhaps has been prominent throughout human history (Mithen 2005). Indeed, in contrast to most animals, humans have a proclivity for music perception and performance from an early age on (Honing 2009; Trehub and Hannon 2006). Where humans prefer hearing music over silence, in non-human primates the situation is quite the opposite, as they prefer silence (McDermott and Hauser 2007). Infants also show a preference for hearing their mothers sing above hearing them speak (Nakata and Trehub 2004). From as early as a couple of months, infants and caregivers engage in exchanges of vocal play that can be said to be precursory to both singing and speech, although these

¹³ This interpenetration of the different causes marks the Aristotelian explanation for the emergence of the political community, in contrast to modern political theory as the latter usually distinguishes between the non-political nature of man and the necessity for him to avoid conflict via the imposed construction of a state (Cherry and Goerner 2006).

exchanges bear yet more similarities to singing than to speech (Papousek 1996).

Apart from this ontogenetic importance of music and singing for human infants, music may also have played an important role in the evolutionary history of humans. More specifically, it has been suggested on the basis of interdisciplinary convergence of evidence that humans have evolved from 'singing Neanderthals': combined with gestures, it were music-like vocalizations that probably made up a communication system that gave the early hominids such an advantage over other animals (Mithen 2005). Providing many benefits in terms of cognitive and behavioral development, social bonding and cooperation, the subsequent evolution of mankind occurred such that its musical abilities further evolved parallel to other abilities like speech. This co-evolution is further proof of the benefits that musical capabilities still provide, even after speech became available to humans in their history as a species or as individuals (Deacon 1997).

Notwithstanding this ancient evolutionary origin and general disposition for music and specifically for singing in humans, there are huge differences in the capabilities that individuals display – differences both in their behavior as in their cognition with respect to vocal music. Though most people can share in singing birthday songs and the like without much difficulty, their performance is poor in comparison to that of an experienced opera singer. Where the former may face difficulties when asked to join in halfway into a birthday song, to shift keys or to sing in another key than their neighbours, to keep on singing while cutting a birthday cake and the like, for opera singers fulfilling such requests is their daily bread. In comparison to non-professionals these singers are faster learners and memorizers and better performers of complex scores - which they have learnt to read and analyze - , better in combining song with other cognitive and behavioral activities, better in monitoring and adjusting their song at will, and all of this with more ease than their amateur counterparts. How are these differences in the cognitive and behavioral expertise to be explained? What causal plurality is involved in musical performance and how do the effects of this plurality converge and diverge from each other? How is an individual's space of actions sculpted by that plurality, and is there adequate coherence and consistency in this action space, or does the causal plurality confuse such an action space? For if habituation were to imply that singing is no longer fit for conscious control, it would be difficult to imagine what role formal music training could play, for example. And yet, even experienced singers continue to train, aiming to improve their vocal control and to practice new scores and refresh their command of previously studied scores.

Nonetheless, research has demonstrated that the differences between experts and amateurs or novices cannot be explained in a plausible way with reference to a single

cause only. Naturally, explanations for these differences in performance capabilities have often referred to an assumed uneven distribution of innate musical talents. However, innate talent is not the primary cause, as it is extended periods of deliberate practice more than anything else that distinguishes the two groups from each other (Ericsson, Krampe et al. 1993). Indeed, the role of practice for the development of specialist expertise has been shown in a variety of domains, ranging from sports to an unexpected domain like medicine (Charness and Tuffiash 2008). So it is not some innate nature on its own that can explain the differences, nor can practice do all the explanatory work, as we need to know what the effects of practice are.

It turns out that musical practice does have effects on the physical and neural resources that are being recruited for musical activities by experts and amateurs alike. Combination of lesion studies and neuroimaging suggests that there are correlations between the differences in expertise and the activations visible at the neural level of individuals' brains. There are some neural areas specifically devoted to musical abilities, as is evident from specific deficits in music cognition or behavior in patients with focal lesions to those areas. A review of evidence suggests that extended musical practice contributes to expertise, because it leads to distinct properties of both the neural organization and the processes responsible for the tasks involved (Peretz 2006).

As research in musical expertise and performance is becoming increasingly popular in recent years, we cannot even attempt to give a comprehensive overview of relevant issues. But the short discussion above already demonstrates that an opera singer's musical performance relies on an extended period of practice involving the interaction of natural neural resources, specific socio-cultural educational processes, patience and perseverance – first relying on parental guidance, after that hopefully on character and motivation – and finally the ability to master a score in harmony with his fellow performers. Clearly then, a plurality of causes already emerges, combining explanatory factors at the level of the brain, the individual's psychological properties and environmental influences of family and society. Explaining such a multi-causal phenomenon requires handling and integrating these different determining factors.

Indeed, causal and theoretical pluralism is becoming increasingly accepted in the life and cognitive sciences. Differentiation between levels of analysis, each retaining a relative autonomy, in biological science has allowed such explanatory pluralism to flourish.¹⁴ Instead of aiming for a unification within a single, comprehensive theory, a more modest form of integration in a complex explanatory account is more plausible

¹⁴ Wimsatt has demonstrated in various contexts that complex and dynamic systems are made up by components that have a 'relative autonomy' within such systems, as not all changes of a system have an immediate impact on the properties of all components, nor vice versa (Wimsatt 2007). In a similar vein, Beatty discusses the example of the contribution of multiple genes to a phenomenon. He refers to the 'relative significance' of distinct theories, each accounting for a particular subdomain within the larger domain of phenomena that a particular theoretical plurality aims to explain (Beatty 1997).

(Mitchell and Dietrich 2006). Within the interdisciplinary domain of cognitive neuroscience, such explanatory pluralism also enables researchers to integrate insights from different disciplinary and theoretical perspectives, accounting for multi-causal phenomena related to the brain, cognition and behavior (Looren de Jong 2002). This includes the methodological step of hypothesizing ‘psycho-neural identities’ which in cognitive neuroscience has been very fruitful in developing pluralist explanations, without surrendering psychology and neuroscience as distinct disciplines nor implying simple reductionism (McCauley and Bechtel 2001; see more on this in section 1.5 on mechanistic explanation). In light of such pluralism, we may expect a plurality of methods and theories involved in the explanation of a phenomenon like musical performance.

In this part, we will discuss four models of scientific explanation that have been proposed as guides to how such complex phenomena can be explained in cognitive neuroscience. In spite of their differences, they all recognize that we need to include two distinct yet complementary ingredients. First, we need to define and describe the phenomenon under scrutiny with the help of an analysis of the concepts we use when referring to it. Second, when employing empirical methods to investigate that phenomenon scientifically, relating the empirical results to the phenomenon should not be taken lightly. Especially when a particular process, which belongs to the plurality producing the phenomenon, is investigated in isolation it may not always be easy to determine its exact role. Our discussion of the four explanatory models will demonstrate that the inclusion of both conceptual and empirical ingredients is in itself not enough to avoid stark differences between the models. Let us mention here in advance just in a few words how the four models to be discussed suggest the configuration of these ingredients.

The first model, discussing philosophical foundations of neuroscience, posits a strict distinction between the conceptual analysis that philosophy provides and the empirical facts that scientists can gather. Assuming that the philosophical analysis yields a consistent and adequate definition of psychological functions like consciousness and perception of pain, empirical science as such has no contribution to offer to assist with regard to conceptual problems, according to (Bennett and Hacker 2003). The second explanatory model distinguishes between three different perspectives on a particular psychological function, like visual perception. One perspective – the computational or task theory – is devoted to the definition of the task and its goals and to its decomposition in component tasks. The other two perspectives are meant to subsequently clarify the implementation of the task: the algorithmic theory should offer potential implementations in terms of the representations and

transformations involved in carrying out the task and the neural implementation theory pertains to potential implementations of the task in the brain. In this case, the three theories are 'loosely' dependent upon each other and can mutually constraint each other somewhat (Marr 1982). The third model loosens this relation between conceptual or definitory ingredients and empirical ingredients even further. It is specifically developed for the investigation of Neural Correlates of Consciousness, but is being applied to other functions as well. Here, the target is to find specific correlations between a specific instance or example of conscious experience and neural activations, for example by looking for brain activation patterns that correlate with the conscious percept of a visual bi-stable object like the Necker cube (Logothetis and Schall 1989). Instead of offering a preliminary definition of consciousness, which has proven very hard to do, some researchers even hope to avoid that task and instead discover gradually a neural correlate that turns out to underlie all different instances of consciousness (Lamme 2006). Although we will argue that this model is in vain trying to avoid conceptual problems, it does hint at the fact that conceptual and empirical insights can be used to mutually constrain each other. This is what the mechanistic explanatory approach explicitly invites scientists to do, as it aims to localize increasingly detailed explanatory mechanisms that are responsible for a particular function. Starting with heuristics that demand a preliminary definition and decomposition of a function, it acknowledges that scientists may have to revisit their initial conceptual insights when the insights in responsible mechanisms suggest to make conceptual adjustments (Bechtel and Richardson 1993). To this strong plea for the integration of insights in the model of mechanistic explanation we will add an analysis how this form of explanation offers the necessary resources for explaining dynamical changes as they happen during development and learning.

After this preparatory work, we can proceed to Part II, where our focus will be on the hierarchical yet modifiable structure of complex cognitive and neural mechanisms like those responsible for action, or for singing. For it turns out that development and learning often lead to such a hierarchical structure, and that it is this structure that is responsible for the individual's enhanced capabilities in terms of increased processing speed, stability, adaptivity and diminished recruitment of cognitive resources. Explaining a complex phenomenon therefore does not only rely on the inclusion of a causal plurality but also needs to account for the dynamical changes that can affect such a structure and its properties. This complicating factor makes the lack of unanimity regarding the preferable model of explanation for this research endeavor even more understandable.

With the help of these results concerning the explanatory nature of cognitive

neuroscientific research and concerning the structure and dynamics of complex cognitive processes we will focus in Part III on the primary object of this dissertation: human intentional action. Treating in parallel philosophical analyses and empirical results with regard to action, we will find how intentional action is similarly determined by a causal plurality that together might explain both differences and similarities between individuals. Intentions will be found to function at different levels of specificity or proximity, with all levels of intentions contributing to an agent's sculpted space of actions as intentions can dynamically affect the mechanisms underlying this space. This space itself enables him to act in a more consistent way than he would have done without such a sculpted space.