

Harleß' Apparatus of Will: 150 years later

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Abstract As the empirical study of action control via ideomotor effect anticipations continues to uncover more and more aspects of this fundamental process, it is time to look back to the 19th century roots of the theory to assess which classical ideas are supported by contemporary research. In turn, classic ideas might stimulate studies on aspects of the ideomotor mechanism that have not yet been addressed empirically. The present article is a tribute to this classical work—more precisely to the article “*Der Apparat des Willens*” [The Apparatus of Will], published by Emil Harleß 150 years ago. At a closer look, Harleß does not only present a concise description of the ideomotor mechanism; he also presents a wealth of intriguing ideas that deserve empirical investigation.

Early ideomotor theory

Over the last two decades, ideomotor theory as a 19th century philosophical approach to human action has stimulated numerous intriguing experiments on this fundamental mechanism (for recent reviews see Nattkemper, Ziessler, & Frensch, 2010; Shin, Proctor, & Capaldi, 2010). While these experiments steadily increased our understanding of the ideomotor mechanism, classical comprehensive accounts of ideomotor action control are about to

fall into oblivion. Symptomatically, of the several hundred papers on ideomotor theory published to date, only one targeted earlier formulations of the theory (Stock & Stock, 2004).¹

Among these earlier formulations are several comprehensive accounts for ideomotor theory, starting with Herbart's (1825) *Psychologie als Wissenschaft neu gegründet auf Erfahrung, Metaphysik und Mathematik*, and continuing with Lotze's (1852) *Medicinische Psychologie oder Physiologie der Seele* and Harleß' (1861) *Der Apparat des Willens*. These classical works offer a wealth of intriguing ideas and point towards important questions that contemporary research has not answered yet. Still, they are not as well known as would be expected based on their potential merit for contemporary research. At least two factors are responsible for this circumstance: First, most classical treatises clearly differ from contemporary research papers in that their length exceeds the concise format of the latter ones where relevant information is assumed to be more readily extractable from a minimum of pages. The second factor is obvious from the titles cited above: most comprehensive 19th century accounts of ideomotor theory were written in German language and are thus inaccessible to the majority of contemporary researchers. The present article aims at making the most concise of these classical accounts (Harleß, 1861) available to the English-speaking world. To this end, the following sections first provide a few biographical notes on the author and continue with a summary of the key points in his *Der Apparat des Willens*.

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¹ In addition to this paper, two historical articles sketch the life of Thomas Laycock (Leff, 1991, 2003), a key figure of the British Tradition of ideomotor theory (cf. Stock & Stock, 2004).

Emil Harleß' and the "physiological-psychological mechanism"

In contrast to his philosophical predecessors Herbart and Lotze, Emil Harleß (Fig. 1) was a physiologist, who had studied medicine, physics, and chemistry in Würzburg and Berlin (Meyers Konversationslexikon 1885-1892). During the first years of his academic career at the University of Erlangen, he focused on experiments on general anaesthetic drugs and published a seminal report in this area together with Ernst von Bibra (Bibra & Harleß, 1847).

Only after becoming a full professor at the University of Munich (Martin, 1857) he started to investigate the "physiological-psychological mechanism", what would today be subsumed under the terms physiological psychology or cognitive neuroscience (e.g., Harleß, 1862). One year before his death—exactly 150 years ago—he published an article where he discussed ideomotor theory in the broader framework of the mind–body problem. This article—*Der Apparat des Willens* [The Apparatus of Will]—is arguably the most concise and comprehensive account for ideomotor action formulated prior to James's (1890/1981) *Principles of Psychology* (cf. Hommel, 2003; Stock & Stock, 2004). It contains a wealth of innovative ideas, some of which have already received empirical support and others that are just now being addressed by experimental studies. An English



Der Apparat des Willens.

Von Dr. E. Harleß, Prof. d. Physiologie in München.

Fig. 1 Emil Harleß (1820–1862) and the original title of his "Apparat des Willens" [Apparatus of Will] (1861). Adapted with permission from Unschuld (1989, p. 34); "Archiv Bereich Physiologie und Physiologische Chemie, Sammlung W. Koller, Munich"

translation of the Apparatus of Will is available as supplementary online material whereas the following sections highlight its most important ideas for contemporary research.²

The Apparatus of Will and future directions

Contemporary accounts of ideomotor theory concentrate on the immediate role of sensory anticipations for the production of motor actions (Hoffmann, 1993, 2003; Hommel, 2009; Hommel, Müsseler, Aschersleben, & Prinz, 2001; Kunde, 2001, 2003). To the contrary, Harleß (1861) conceives ideomotor theory as a broader approach to the philosophical mind–body problem, including the classical controversy about human free will and related issues such as its legal implications. Consequently, the first part of the article ("The foundations of voluntary action") contains a thorough discussion of the relationship of voluntariness, consciousness, and purposefulness of voluntary actions.

Regarding this distinction, Harleß (1861) arrives at the interesting conclusion that an action is most likely to appear voluntary to an observer if it does not serve an apparent purpose, i.e., when it does not seem to be motivated by situational demands (labelled *incidental actions*). The conclusion that such incidental actions give rise to the most intense impression of voluntariness is supported by several recent studies on imitation behaviour. In these studies, human infants and chimpanzees tended to imitate unusual object-oriented actions, such as pressing a button with one's forehead, only if the agent could have used his hands easily instead of the forehead but not if the agent's hands were occupied (e.g., Buttelmann, Carpenter, Call, & Tomasello, 2007; Gergely, Bekkering, & Király, 2002). In accordance with Harleß' deduction, actions that do not seem to be motivated by situational demands (in this case: having his hands free instead of carrying an object), do indeed seem to have a special influence on the observer. The discussion of such incidental actions also leads to a fine-grained analysis of voluntary action. For instance, Harleß suggested that voluntary actions do comprise decisions about whether an action should be carried out at all—a notion that was recently taken up in

² Translating a 19th century German article into modern English is difficult for a number of reasons. Most importantly, a translation that is close to the original wording will effectively obscure its gist in most instances because of the completely different approach to scientific writing that is obvious from many classical treatises. For this reason, we focused on the meaning of the text at the expense of a limited conservation of its original style. Following the same line of argument, we introduced subheadings as a major stylistic change to make the text more accessible.

the What-When-Whether model of intentional action (Brass & Haggard, 2008).

The first part of the article ends with the claim that incidental actions are the key to understanding voluntary actions in general. This idea was addressed in various recent studies where the term ‘incidental actions’ was substituted by the concepts of self-initiated (Jahanshahi et al., 1995), endogenous (Astor-Jack & Haggard, 2005), and intention-based actions (Herwig, Prinz, & Waszak, 2007; Pfister, Kiesel, & Melcher, 2010). The question of how such actions—in contrast to immediate reactions to external stimuli—might promote ideomotor learning or the anticipation of distal action effects is just now being addressed by empirical studies (Dutzi & Hommel, 2009; Haering & Kiesel, (2011); Herwig et al., 2007; Herwig & Waszak, 2009; Janczyk, Pfister, & Kunde, (2011); Pfister et al., 2010; Pfister, Kiesel, & Hoffmann, 2011; Stock & Hoffmann, 2002; Wolfensteller & Ruge, (2011)).

The second part of the article (“The physiology of incidental actions”) is concerned with the physiological implementation of voluntary actions in general and incidental actions in particular. Like other physiologists of his time (e.g., Laycock, 1845), Harleß (1861) assumes two qualitatively different functional units of the nervous system: a sensory unit (*sensorium*) and a motor unit (*motorium*). Accordingly, activations have to be relayed from the former system to the latter system in order to produce adaptive action. A considerable proportion of the article is devoted to this question which has had a relatively limited impact on contemporary research. Notable exceptions include recent neuroimaging studies on the acquisition of bidirectional action-effect associations (Elsner et al., 2002; Melcher, Weidema, Eenshuistra, Hommel, & Gruber, 2008), the sensory nature of effect anticipations (Kühn, Seurinck, Fias, & Waszak, 2010; Kühn, Keizer, Rombouts, & Hommel, 2011), and the electrophysiological signature of effect anticipations (Waszak & Herwig, 2007; Nikolaev, Ziessler, van Leeuwen, & Dimova, 2008). In this respect, Harleß seems to have foreseen the advent of neuroimaging methods in claiming that “activity of the soul” will inevitably increase the blood flow in the activated brain regions—preparing the theoretical stage for an fMRI analysis of ideomotor processes. Still, however, the neurophysiological mechanisms that relay effect anticipations to motor centres are virtually unknown and will have to be uncovered in the years to come. A promising start in this enterprise might be the integration of ideomotor theory and recent concepts in computational neuroscience, such as forward and inverse models (e.g., Wolpert & Kawato, 1998).

A third part of Harleß’ (1861) article covers the acquisition of bidirectional action-effect representations for humans and animals (“The acquisition of behavioural competence”). Like prior accounts (Lotze, 1852), this

description is relatively vague; yet, it suggests an important role of incidental movements during prenatal development. This discussion already contains important thoughts about the contextual nature of action-effect representations that were later addressed empirically (Hoffmann & Sebald, 2000; Kiesel & Hoffmann, 2004). The later ontogenetic development of action-effect representations is not covered in the Apparatus of Will but is certainly an important addition to the considerations raised by Harleß (e.g., Eenshuistra, Weidema, & Hommel, 2004; Karbach, Kray, & Hommel, 2011; Verschoor, Weidema, Biro, & Hommel, 2010). Interestingly, Harleß explicitly suggested the acquisition of action-effect representations to be subjected to preparedness for learning specific action-effect relations while other relations are much harder to acquire. Even though this notion was empirically tested in operant conditioning experiments with rodents (Bolles, 1970; Randolph, 1986) it has not yet been applied to human agents.³

The major part of Harleß’ (1861) article describes a physiologically motivated schematic of action control via ideomotor effect anticipations (“A physiological-psychological mechanism for voluntary actions”; Fig. 2). Interestingly, Harleß already employed the modern term of action effects and pointed towards the contextual dependence of action-effect associations (Hoffmann, 1993; Hoffmann & Sebald, 2000). In contrast to contemporary experiments which exclusively studied the situational context, Harleß proposed a much broader definition, including the internal context such as the current mood or arousal level. Whereas the internal context has been investigated in other domains of psychology (e.g., regarding mood-congruent memory; Bower, 1981), its role for ideomotor processes still has to be uncovered. Furthermore, Harleß explicitly discusses the role of proximal and different types of distal effects—a discussion that empirical studies are just now beginning to take up (Janczyk, Skirde, Weigelt, & Kunde, 2009). Importantly, Harleß also emphasises a unique role of the valence of actions and their effects for acquisition and application of action-effect associations that, up to now, has only played a minor role for contemporary research and theory (but see Beckers, De Houwer, & Eelen, 2002; Eder, Müsseler, & Hommel, (2011); Kunde, Lozo, & Neumann, (2011)). Both, the distinction between proximal and distal feedback and the role of valenced action effects, have direct implications for future research. Action effects are no longer to be seen as a homogenous class of events that are only defined by their

³ In contrast to the study of preparedness, there is another striking imbalance regarding the explicit study of ideomotor action-effect associations which was almost exclusively studied with human participants. A notable exception is a study on action-effect associations in the fruit fly *Drosophila* (Gerber & Hendel, 2006).

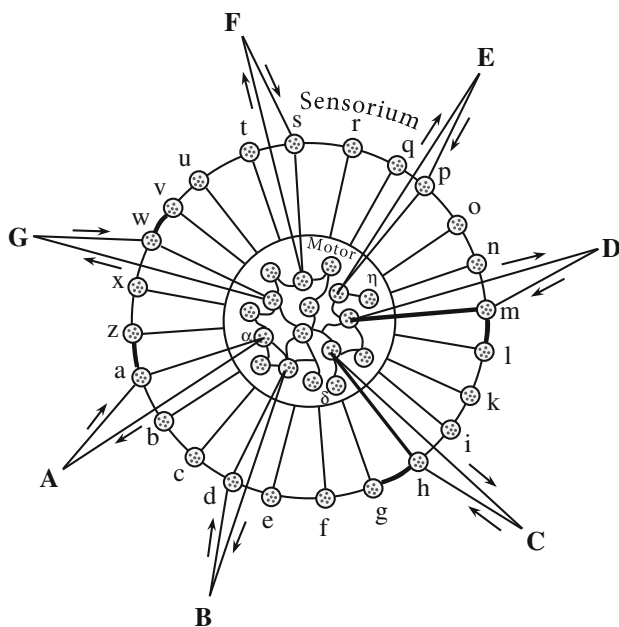


Fig. 2 A redrawn version of Harleß' (1861, p. 62) schematic describing the physiological basis of the ideomotor mechanism. Elements in the centre of the schematic represent motor units (α , δ , η) which are able to evoke bodily movements (A, B, C) via appropriate connections. These movements, in turn, produce sensations (a, b, c). Only these sensations can be controlled by the "will" and they project back to associated motor units

contingent mapping to an action. To the contrary, the exact properties of action effects have to be taken into account to arrive at a clearer understanding of their role for human and non-human action control.

Conclusions

The preceding sections aimed at exemplifying how Harleß' (1861) conception of the Apparatus of Will might guide future research on ideomotor action control. Two further points, however, should not be forgotten. The first point is concerned with theoretical underpinnings of ideomotor action control. Since Harleß' days, major theoretical advances were sparse and centred about the learning mechanisms of Anticipatory Behavioural Control (Hoffmann, 1993, 2003) and the immediate interface of perception and action as conceptualised in the Theory of Event Coding (Hommel et al., 2001; see also Hommel, 2004, 2009). Still, ideomotor theory has remained a relatively vague idea—a metatheoretical framework to integrate empirical findings with limited capabilities for deriving predictions for a specific experimental setting. Future theoretical developments are needed to overcome this status: Which circumstances promote the anticipation of distal action effects? What is the role of emotional states in

ideomotor processing? Is it possible to derive a computational framework for ideomotor theory?

These questions point at important theoretical developments in order to integrate the available evidence. Yet, such an enterprise can only be effective if the insights from ideomotor research and theory can be effectively disseminated to those outside the immediate scientific community. In the words of Emil Harleß (1861, p. 73): "May the appeal of this secret, which everybody carries within him- or herself, help to attract attention to this isolated chapter of physiological psychology [...] also from a much broader point of view."

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