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Editors' Introduction to Tasks, Tools, & Techniques

Wayne Douglas Gray¹, Françoise Osiurak², and Richard Heersmink³

¹Cognitive Science – Rensselaer Polytechnic Institute

²Laboratoire d'Étude des Mécanismes Cognitifs – Institut Universitaire de France

³Philosophy Department – La Trobe University

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use me!

Author Note

Correspondence should be sent to Wayne Douglas Gray, Cognitive Science Department, Rensselaer Polytechnic Institute, Troy, NY 12180. Email: wayne.gray.psycsci@gmail.com. The work was supported, in part, by grant N00014-16-1-2796 from the Office of Naval Research, Dr. Ray Perez, Project Officer.

Abstract

Tasks, Tools, and Techniques that we perform, use, and acquire define the elements of expertise which we value as the hallmarks of goal-driven behavior. Somehow, the creation of tools enables us to define new tasks, or is it that the envisioning of new tasks drives us to invent new tools? Or maybe it is that new tools engender new techniques which then result in new tasks? This jumble of issues will be explored and discussed in this diverse collection of papers. Individually, few of the papers are related to each other by topic or by techniques of analysis. Collectively, all focus on tasks performed using tools and discuss the techniques of tool use which enable differences in performance and expertise across individuals, societies, and (even) species.

Keywords: animal tool use, constructing expertise, varieties of artifacts, teaming with your car, brain, mental imagery for motor acts, foragers and their tools, gestures, tool embodiment, spatial perception

Editors' Introduction to Tasks, Tools, & Techniques

1 OVERVIEW

Tasks, tools, and techniques – our daily lives are so enmeshed in these that it is sometimes hard to see our forest for our trees. Just as speaking is cognitively a different act than is writing, so writing with a feather quill is both mechanically and cognitively different from writing with a pencil which is different in both ways from writing with an old Underwood typewriter which is different in many ways from writing with Microsoft Word on a modern computer which is very different for users of \LaTeX . Of course, this is not to imply that the medium is the message as, in this case, it is not. Rather, the message is that we used to pause in some places not just to gather-our-thoughts but to take one page out of the typewriter and insert a blank page in. How much was our “attention to writing” devoted to keeping our quill-point sharp and our wet-ink blotted? Did the pauses that were needed to grab hold of the carriage-return lever (how many readers know that “carriage return” used to refer to a physical activity??) and return it to the left-side of the typewriter while raising the paper by one line – were these pause-times wasted or was that time used to reflect, if ever so slightly, on our manuscript? That is, did differences in the tool of typewriting result in changes to cognition? While typing is a convenient example, the broader issue is whether and, if so, how our tools and our techniques for using our tools influence the products of our cognition? There are many ways of answering this question and our 11 authors ask and answer it in, at least, 11 different ways.

The papers in this topic were written by researchers with a common interest in tool use – but the specifics of their research foci varies vastly from one research group to another. One paper brings a dynamic systems perspective to driver behavior that is all about being a part of the tool of car driving (Morris, Craig, and Mirman 2021). Another worries about whether the evolution of symbolic language and tool use was independent or dependent on each other, and if so, whether the traces of these developments still remain in the human brain (Osiurak, Cretel, Uomini, Lesourd, and Reynaud 2021). A third takes a cognitive psychology perspective to examine what our tools for professional sports, eating dinner, and other daily activities tell us

about the role of expertise in tool embodiment (Weser and Proffitt 2021). Another seeks to go beyond debates about the extended mind to explore the relationship between evocative objects and lifelogging technology (Heersmink 2021). This work is based on cultural evolution and developmental psychology, and uses the case study of spatial navigation to demonstrate its core claims. Yet another (Sterelny 2021) explores the subsistence technology of forager communities in a discussion that evokes, in my mind, the stories of William Buckley and his life among the Australian aborigines in the early 1800s.¹ Another takes an expertise perspective to explore how the techniques that individuals develop for using the tools of Tetris lead some players to short, deadend plateaus while enabling others to leap to the next level of skill (Gray and Banerjee 2021).

The above list of topics is not our limit. Others of our researchers find that blind cane users feel the curb not the cane itself and that tennis players feel the racket as a part of their body (Witt 2021). One group of contributors are dismayed by the state-of-the-art in research on animal tool use and propose a very interesting reboot of that field (Colbourne, Auersperg, Lambert, Huber, and Volter 2021). Another views cognitive tools as transforming the nature of human cognition (Menary and Gillett 2021), while another targets her report on “gestures as thinking tools” (Tversky 2021). Lastly at the ultimate end of this list, the last paper we introduce here argues that our bodies are the ultimate tool (Rosenbaum 2021) and that the key to understanding our use of more physical tools is to study the brain’s control of the body.

2 INTRODUCTION TO OUR TOPICS

2.1 Non-Human Tool Use – Overrated or Poorly Defined?

With the Colbourne, Auersperg, Lambert, Huber, and Volter (2021) paper, we lead from an important subfield of tool use in which a debate rages over what seems a reasonable proposal to address misconceptions regarding animal tool use by attempting to rationalize the rules of evidence.

¹ See Henrich (2020) and McDonald (2021).

Our authors favor adopting the tooling (Fragaszy and Mangalam 2018) framework to separate tool-use from non-tool-use activities in nonhuman animals. This framework views tooling as a specific category of tool use actions, which excludes actions, such as throwing or dropping a stone to break an egg, from this body-plus-object system. Colbourne et al. survey all tool-use examples documented by Shumaker, Walkup, and Beck (2011) and finds that tooling appears to be phylogenetically less widespread than tool use with the variability being greatest in the primate order. Interestingly, the concept of tooling refers to an embodied process, which seems very close to some of the ideas presented by Weser and Proffitt (2021, this issue).

2.2 Varieties of artifacts: Embodied, perceptual, cognitive, and affective

Richard Heersmink's paper is difficult to summarize but easy to recommend. Indeed, the best overall summary is the one given by the author as his primary goal; namely, to map "the landscape of relations between embodied minds and various kinds of artifacts." In this effort he defines four categories of artifacts; namely, "those that aid us in achieving our (1) motor, (2) perceptual, (3) cognitive, and (4) affective tasks/goals." This is a bold task to take on, however, Heermink wisely chooses to not be bogged down by attempts to define sharp boundaries.

Although the boundaries between of his distinctions may not always be sharp, they manage to be clear and insightful. In section three of the paper by discusses "Embodied Artifacts" which "perform their function only when we bodily interact with them." After a short and insightful discussion, "Perceptual Artifacts" are introduced as helping "us perceive or quantify the world better." Glasses and hearing aids are the first two objects discussed but these are quickly followed by a discussion of various imaging device "like ultrasound, MRI, night vision goggles," and more. Cognitive artifacts come next. These are material objects or structures which assist us in performing cognitive tasks – where example cognitive artifacts include maps, labels, abacuses, indexes, and much more.

The author draws few conclusions from his discussion of cognitive artifacts but that was not his goal. Rather, his goal was to define a "comprehensive overview and analysis of the

various ways material artifacts relate to the embodied mind.”

2.3 Expertise in Tool Use Promotes Tool Embodiment

Weser and Profitt examine the curious but well-accepted phenomena that frequent use of a tool often results in it feeling as an extension of the hands or other body parts which use the tool. The more expert the user, the more intense this feeling. Hence, the often-used example of the blind walker’s cane feels, to its blind walker, as if the tip of the cane is sensing the various up and downs of the path or smoothness or unevenness of the terrain. Indeed, according to Weser and Profitt, the cane allows blind users, “to integrate auditory and tactile information as they touch the area immediately in front of them with the cane’s tip.” Perhaps even curiously, the more expert the tool user is in using her tool, for example, a fencer’s personal epee, the greater the discomfort felt when asked to use an unfamiliar epee. To a novice an epee is just a fancy name for a sword, but to the expert, her personal epee is an extension of her arm. The last sentence of the paper provides an apt summation of the authors’ conclusions; namely, Expert effects in the tool-use literature signal the ways in which experts embody their tools in a manner more pronounced than has typically been documented in tool-use studies that do not employ experts (Weser and Profitt 2021).

2.4 The Expertise Approach Applied to Tetris: The Limit is Not the Tool, but the Techniques

In common with Weser and Profitt, Wayne Gray and Sounak Banerjee also adopt the expertise approach but their task is the classic game of NES Tetris. Simple objects do not imply simple techniques. For example, knowing the right technique to weave the right material could make all the difference in your ability to make a fishing net to feed your group. Likewise, if you were a NES Tetris player from the 1990’s up until sometime in the 2010’s, it is likely that your Tetris level of play had an upper limit of level 18 or, at the most, level 19. Today that limit is level 30 with recent discoveries (Macdonald 2021), once mastered, expected to exceed that play level. However, in this paper Gray and Banerjee’s do not focus on the extreme experts of the

Tetris world but on a dataset of 492 students who played Tetris under laboratory conditions in which each move of a Tetris zoid was rated in terms of 35 features of Tetris play. The result is an instructive study of how expertise is constructed not in one leap but by making many tiny explorations and adjustments until new skills emerges.

2.5 Tool Use Affects Spatial Perception

As Weser and Profitt (this issue) reminded us, tool use affects perceptual experience in a surprisingly large number of ways. Jessica Witt's paper nicely complements the Weser paper by avoiding work on expertise per se and focusing more on the impact of virtual tools on spatial perception.

The Pong Effect uses variations on the video game "Pong" and manipulates changes in paddle size to affect subjects' ability to block the virtual ball. One of the important and interesting aspects of this work is that changes in paddle size affected not just the players' likelihood of hitting the ball, but their estimate of the speed of the ball. Smaller balls were perceived as moving faster than larger ones. Witt's paper presents a detailed account of the various alternative hypotheses that she and her collaborators considered and the various experiments they conducted which ruled out most of them.

In general, the paper provides a readable and personal history of the development of research and theory in how tools change the "action capabilities" of people. We especially appreciated her discussion of J. J. Gibson's work (e.g., Gibson 1933; Gibson 1941; Gibson 1977). Although Gibson stressed the importance of perception for action, he considered the main role of perception to be the perception of possibilities for action, not spatial perception per se. We also like her mention, almost in passing, of her very recent and, unfortunately, all too timely, discussion of how the nature of an object affects its perception. In that study, the task varied between identifying a gun being held versus identifying other objects. As she tells us, "When the object shown in the photograph was a shoe, participants were slower and less accurate to identify it when the participants held a gun than when they held a spatula (Witt et

al., 2020). Wielding a gun makes a person a shooter, and shooters had a harder time identifying non-guns in the photographs.”

2.6 Co-Evolution of Tool Behavior and Language

Francois Osiurak, Caroline Cretel, Natalie Uomini, Mathieu Lesourd, and Emanuelle Reynaud pursue the “shared neurocognitive processes hypothesis” which maintains that the emergence of language skills within the left inferior parietal lobe (Broca’s area) led to the development of tool-making skills. This technical-reasoning hypothesis “posits that people first reason at a technical level to create a representation of the mechanical action appropriate to solve a physical problem. Then, this representation biases the selection of the appropriate motor actions to realize the mechanical action generated through technical reasoning.” Interestingly, by this framework, manipulation knowledge is not needed to use tools.

The exploratory nature of their research is complemented by an extraordinary array of Supplementary Materials which provide a large, if not exhaustive, listing of 125 studies for the brain areas investigated in their paper (to be clear, this listing is in addition to the 126 references included in the Reference section of their paper). While we seldom become excited by such catalogs, in this case the listings emphasize the importance of the left posterior and parietal areas for an extraordinary number of cognitive tasks. Perhaps we are making a classic where there is smoke there is fire mistake but this listing, in addition to the references cited, increases our confidence in their association between language skills and the development of tool-making skills.

2.7 Driven to Learn

One of the Editors of this topic recently replaced his 15 year old car with a new one. Whereas his old car had a “cruise control”, his new car has an “advanced driver assistance system (ADAS)” such as the ones discussed by Morris, Craig, and Mirman. During long drives on low traffic, 3-lanes in both directions, Interstate Highways, if left to itself (e.g., while the driver is listening to a podcast), the ADAS will gradually slow down to a cruising speed which

matches the car in the lane ahead of it (this “feature” is referred to by our authors as ACC or Adaptive Cruise Control). Hence, before he knows it, our human driver (with ADAS) is driving 10 mph below the posted limit and his 90-min drive begins to turn into a 2-hr one. Is this horrible? Well, of course not, but when asked, the driver reports that, all else equal, he would gladly abandon ADAS and return to the much more primitive (but predictable) cruise control on his previous, 15+ year old car – a system that requires the driver to continually monitor the distance between his car and the car immediately ahead in the same lane. On the other hand, these “dislikes” do not seem to be the inevitable result of technology gone bad. Rather, they seem more as a phase which our car technology (and drivers) are passing through. Hence, we are very hopeful that the Morris, Craig, and Mirman team will continue their research and continue working with their engineers so that our technology meets not just our needs but, also, our desires.

2.8 Foragers and Their Tools: Risk, Technology and Complexity

Sterelny provides us with the details of a world that some of us never suspected existed. Namely, a detailed look at ancient and modern foragers and the ways in which their lives were shaped by risk, technology, and complexity. The paper focuses on the late Holocene which began approximately 11,650 years before the present and continues to this day. Spanning the breath of this era, Sterelny covers the beginnings of the Holocene from the ancient record as well as data collected from modern foragers living in the Canadian north or the Ju/'hoan Bushmen from Namibia.²

An interesting feature of Sterelny's paper is his discussion of the trio of Tasks, Tools, and Techniques. The original fishhooks were not barbed. Which great genius was it who added the first barb to her fish hook?? Would we call this the invention of a new tool? Or was it the discovery of a new technique?? Can a technique be invented for a tool that does not yet exist??

² Note that one Editor remarks that he found the background provided by Chapter 2, of Joseph Henrich's (2020) book, *The WEIRDest People in the World*, aided in understanding some aspects of Sterelny's paper. That chapter begins with the story of William Buckley who in 1802, after deserting the Royal Navy, lived his next 25 years with members of the Wathaurung tribe of Australian aborigines.

Or is it simply that every tool ever invented required an idea of how it would be used if it were made? The typewriter story is a lot like this as the typewriter was invented before touchtyping. Indeed, hunt-and-peck typing still exists, especially in engineering communities. How many inventions were invented before the modern technique for using them was discovered? How much motivation did the first “touch typist” need to invent touchtyping? (For two stories of how this might have happened see, (Wikipedia 2015; Wikipedia 2016).)

2.9 Cognitive Tools in Enculturation

Richard Menary and Alexander Gillett begin by asking, “Why are humans so strange?” which they quickly restate as, “what is the key property that identifies human uniqueness?” They then identify three kinds of cognitive tools: (1) cognitive tracking tools (e.g., a compass), (2) representational systems (e.g., a diagram), and (3) combinatorial cognitive tools (e.g., a radar system). These authors argue that when such cognitive tools are properly integrated into the cognitive systems of their users, they do not just scaffold our cognitive capacities, but become constitutive parts of our cognitive processes. This accommodation of tool into human cognition is not instant. Indeed, by their view, the integration of tool into human cognition extends over evolutionary and developmental time as we learned and learn how to use and manipulate tools in the service of cognitive tasks. However, the authors make a more controversial statement; namely, that learning how to manipulate cognitive tools transforms not just the task but also the neurocognitive profile of the agent.

2.10 Thinking Tools: Gestures Change Thought About Time

Barbara Tversky starts her paper by playfully suggesting that, as a species, we change our name from Homo sapiens to Homo faber, the toolmaker or designer – we are a species that “makes an enormous variety of tools, primarily with our hands, and those tools make artifacts that enhance our well-being.” However, Tversky’s main focus is on our cognitive tools, among which she includes gestures, language, and graphics with her main focus on representational

gestures. For representational gestures, form follows function. Gestures that signal a given action often mimic the action. Gestures are also used to convey either time or sequence.

Four experiments are presented. All entail simple manipulations which had surprisingly strong effects. If the data were not so clear it would be hard to imagine that such simple manipulations, gesturing one way or another, would have such strong effects. Tversky has written a simple but incisive paper that deserves a deep reading.

2.11 The Ultimate Tool

David Rosenbaum leads us in an intellectual romp which starts with a series of vivid assertions. "Tools are often seen as extensions of the body." The body itself "can be regarded as the ultimate tool." Hence, body movements can be regarded as tools for manipulating the body. This is an interesting, different, and a somewhat "fun" way of thinking about familiar issues. Indeed if the ultimate tool is the brain and body, then we should be concerned with the two foundational issues which Rosenbaum addresses; namely, choices which are made with reference to motor imagery but without necessarily executing the move (Jeannerod 1994; Jeannerod 2017) and choices based on evaluating candidate postures with respect to how well each posture satisfies current needs. The favored model does not use motor imagery or full simulation to "determine whether it would be wise to move one way or another. Rather, critical features of candidate positions, and critical features of candidate movements, are used to plan the acts to be performed." Rosenbaum concludes that, "The fact that distinctive features are used for planning individual limb displacements as well as entire sequences of limb and body acts lends credence to the view that distinctive features are core elements of action, much as they have long been understood to be core elements of perception."

3 SUMMARY

Tasks, Tools, and Techniques . . . the serial order of these three terms implies a logic that may or may not be supported by all authors in this special issue on tool use. Does the tool define or delimit the techniques by which it is used? Or, do the techniques determine the nature

of the tool? Tools are simple! Time and time again, even simple, 1-hr long psychology laboratory studies, lead individual subjects to discover new techniques for using a tool to perform a simple laboratory task.

Indeed, it is somewhat fun to consider parallels between the toolkits of the early late Holocene era and the toolkits of the late late Holocene, weekend, repair person. Like these ancestors, any weekend repair person knows the distinction between the “preferred material” and the “available material” and, likewise, between the “preferred tool” and the “available tool.”

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