

Perceiving and Remembering Routine Action: Fundamental Micro-Level Origins

Michael D. Cohen

School of Information, University of Michigan

Keywords: capabilities, habit, learning, micro-foundations, routine, skill

In the contemporary research literatures on organization and on business strategy, *routine* is understood to be a distinct modality of organizational action – not merely the joint result of individuals making choices that maximize self-interest. As Herbert Simon (1996) pointed out, if this were not so, the observed stability of routines would merely be a reflection of the stable requirements of the environment within which individuals would be optimizing their behaviour. When the environment changed, behaviour would quickly follow and we should not expect routine's notorious 'resistance to change'.

However, this special issue affirms that routine *is* a distinctive mode of organizational action, and the title phrase 'micro-level origins' directs us to closer observation of the underlying individual processes that generate routine action. Correspondingly, the assumptions about those micro-level processes that we put into our theories of routine will shape theoretical derivation of the expected properties of routine action, and of the organizations whose distinctive capabilities (Dosi et al., 2000; Teece et al., 1997) rest on routine. Observation, theory, and theory-based intervention will all be affected by more accurate foundational assumptions.^[1]

My central assertion is that the distinctiveness of the routine mode of action stems from its being grounded in an ensemble of individual psychological processes that may be grouped together with the broad term *habit* (Neal and Wood, 2008; Neal et al., 2006; Rangel, 2009; Redish et al., 2008; Yin and Knowlton, 2006). It is the relationship of organizational routine action to the individual habit system that I would urge researchers to investigate.

The full development of the relationship and its implications will not be simple. Habit is subtly connected to systems of emotion. It is different from, but can arise from, more deliberate and conscious action (Graybiel, 2008). And while habits can verge on

Address for reprints: Michael D. Cohen, School of Information, University of Michigan, Ann Arbor, MI 48109, USA (mdc@umich.edu).

addictions and be notoriously difficult to change (Everitt and Robbins, 2005), they can also show flexibility in adapting to context (Imamizu et al., 2003). Although the routines of a group are conceptually different from the habits of individuals, all these qualities can be observed as well in routine organizational activity (e.g. Feldman and Pentland, 2003). And just as habit can – often with some difficulty – be reshaped by conscious intervention, so, too, can organizational routines.

Though challenging, a deeper understanding of how organizational routine emerges from individual habit will be extremely fruitful for key lines of inquiry into organizations and strategy, such as the role of artefacts in coordination and the development of routines in some work teams that can be highly adapted, while others resist needed change.

While there is much to be learned, there is already a great deal known. In particular, as individuals carry out their parts in organizational routine, they appear to rely substantially on two psychological capacities that are fundamental components of the habit system: (1) *procedural memory* for our habits and skills, also referred to as non-declarative memory (Singley and Anderson, 1989; Squire and Kandel, 1999); and (2) action-specialized perceptual capability, that has been labelled in recent research as the *dorsal perceptual system*, in contrast to the ventral system.^[2]

Unlike the human capacities for object recognition and for self-conscious reasoning about problems, which have been more extensively studied, non-declarative memory and the dorsal perceptual system are mechanisms that have relatively recently developed as foci of psychological study, exploiting both advances in imaging and the observation of brain-injured patients who lost some abilities but surprisingly retained others.

This work has shown that we have multiple systems of both memory and perception, and these systems have distinctive properties. Procedural (or non-declarative) memory plays a central role in our retention of how actions are performed. It corresponds to what we term ‘know-how’, in contrast to ‘know-that’, which is more strongly associated with declarative memory.^[3] Our habits and skills – where the latter may be roughly defined as our useful and cultivated habits – are remembered using the non-declarative system. We have much reduced conscious verbal access to our know-how. It operates rapidly, with little demand on our conscious attention. It can occasionally be triggered inappropriately by circumstances that superficially resemble prior experience. It has a very low rate of decay, relative to declarative memory. Taken together, these properties imply that you have the speed of action required to successfully ride a bicycle, or conjugate verbs, and can do so while attending to other tasks. But you may be hard-pressed to say just how you do these things and – for the most part, fortunately – relatively slow to forget how you do them.

The more recent work on visual perception has differentiated a parallel set of systems, ventral and dorsal. The ventral pathway runs towards the areas that, in humans, play a central role in speech (Saur et al., 2008). As with the procedural memory system, we have reduced ability to articulate the workings of our dorsal perceptual apparatus. Though perception of unfolding events is clearly needed to guide our action, it may not be easy to say explicitly what triggers our readiness for subsequent steps in habitual or skilled activity.

The dorsal perceptual pathway has a clear association with preparation for action. Indeed, one of the observations that led to ventral/dorsal distinction was a patient who

had suffered specific damage to the dorsal pathway, who could readily distinguish presented objects based on their shapes, but who could not correctly take into account the shape of an object in preparing to grasp it (Goodale et al., 1994). Conversely, the patient DF, whose ventral damage prevented recognizing the shape of a stick, could nonetheless catch a stick when it was thrown to her (Milner and Goodale, 1995).

As mentioned, there is still considerable work underway to tease apart the predominant functions of – and to document the crosstalk between – the two main pathways of visual perception. The relationship of the still broad-brush physiology to detailed functional variation is far from simple (see, e.g. Coello et al., 2003; Farivar, 2009). But the basic divergence has been heavily supported. Preparation for action requires location with respect to one's own body, and refined assessments of changing positions in space. The dorsal system has high temporal resolution (Norman, 2002), and is especially active in determining the relationship of objects and events to one's own body. The ventral system is better at spatial resolution and at positions of objects relative to each other and, as mentioned, is more accessible to conscious awareness (Goodale et al., 2004).

The distinctive qualities being documented for these psychological processes in the habit system have important implications for research on organizational routine. Common properties of organizational routines reflect those of the memory and perceptual systems used when individuals remember and generate their actions as participants in routines.

The work to establish these organizational implications of individual psychology developed first around the idea of procedural memory. Laboratory experiments that induce routine activity in a small group of subjects demonstrated that properties of routine activity, such as fast action, slow decay, and inappropriate firing could be traced to the development of procedural memories for action in the experimental participants (Cohen and Bacdayan, 1994; Egidi and Narduzzo, 1997; Wang and Zhang, 2008). This work can be seen as providing a psychological ('micro-origins') account of several of the main properties of routine that were developed in classic organizational discussions, such as the influential chapters on individual skill and organizational routine in Nelson and Winter's *Evolutionary Theory of Economic Change* (Nelson and Winter, 1982).

The newer results on the properties of the dorsal perceptual system have not yet been carried into the organizational domain, but a parallel line of development seems very promising. As was the case with the earlier work on procedural memory, there is a strong alignment of known properties of routines with findings on the dorsal perceptual system in individuals and small groups. The dorsal system is heavily involved in preparation for, and guidance of, familiar actions, such as driving oneself to work (Custers and Aarts, 2010). Many of the informative results about dorsal perception have been established by studying disjunctions or illusions, in which the dorsal system is driven by situational cues to guide action inconsistent with verbally reported ventral perceptions of the scene (Milner and Dyde, 2003). So, for example, cues cleverly arranged to be undetectable by the ventral system still affect the execution of grasping or pointing gestures (Coello et al., 2003). This sensitivity to priming is suggestive of the organizing force of perceiving familiar tools and colleagues, which is often observed in episodes of inappropriate routine triggering (Cohen and Bacdayan, 1994).

A number of psychologists (Rizzolatti and Sinigaglia, 2008; Warren, 2006) have argued that the dorsal system provides a mechanism for phenomena of *affordance* that were so forcefully advanced by the environmental psychologist J. J. Gibson (1979). He argued that we directly perceive something as 'sit-able' or 'climb-able' relative to our own bodies and that is part of how we recognize it as a chair or stair. This is in contrast to the view that we first recognize a chair or stair, and then retrieve further properties such as sit-ability or climb-ability. Gibson's view suggests that artefacts can play a much stronger role in organizing our actions. In his perspective, we see the experience-based action possibilities of a situation directly, in contrast to a much slower process of reasoning them out based on alternative behaviours and likely consequences. Since artefacts, such as tools and visual displays, play a significant role in many accounts of organizational routine (Latour, 2005; Pentland and Feldman, 2008), there is much research potential in a perceptual mechanism that provides a more detailed account of how such objects affect our organizational action, and includes an explanation of how they may sometimes 'misfire', overriding our reasoning about the requirements of a situation.^[4]

A second role of the dorsal system is its contribution to *anticipation*, a hallmark of action sequences in individual skills and organizational routines. Even in patients whose ventral systems are damaged, the fingers widen appropriately long before the hand arrives at the object to be grasped. In the card game task that becomes a routine for experimental subjects (Cohen and Bacdayan, 1994), experienced players ready the card they will play next while waiting for the move they know their partner is about to make. The same mechanism can be seen in experienced teams on assembly lines as workers place items where their colleagues will need them.

Anticipation allows routine action to be more rapid as activities that prepare for a later step can be overlapped with a current step, rather than waiting for the starting point of the following step to be fully realized by current action. It carries risks, of course. Leaping towards the rim can look a little foolish if the basketball is never passed to you. But in recurring environments, such as team sports or surgical teams, such risks are usually far outweighed by the benefits of speed and relatively continuous mutual adjustment.^[5] Further, work on 'mirror neurons' in macaques (Umiltà et al., 2001) and humans (Rizzolatti and Sinigaglia, 2008) strongly implicates the dorsal perceptual system in understanding the intent of actions by others, an additional crucial aspect of routine.

In sum, new understanding of the dorsal perceptual system will give researchers valuable insights into major aspects of organizational routine, such as collective affordances of artefacts, the role of anticipation in practiced teams, and the understanding of collective intent.

New results on dorsal perception and the earlier work connecting memory for routine action to non-declarative memory for habits and skills, show that routine action depends heavily on what has been called the 'habit-system' within human individuals (Mishkin et al., 1984; Redish et al., 2008). Psychology has been steadily revealing interlinked mechanisms of memory for, and generation of, action that do not depend on deliberation over likely consequences. Rather action is generated based on perception of situational features and memory from previous action. The development of this perspective restores for us an understanding of action that complements – but does not replace – the perspective of deliberate choice. It revives a more differentiated worldview of a century

ago, when American Pragmatists such as William James, C. S. Peirce, and John Dewey recognized *habit* as one of the fundamental human faculties, one that interacts with reflective *thought* and *emotion*-laden instinct.

NOTES

- [1] Here I use the term 'routine' since that is the label under which the special issue has been convened. Elsewhere (Cohen, 2007), however, I have analysed problematic features of the term. It could be that a careful analysis of micro-level origins leads to the conclusion that 'routine' is not the right label for the phenomena of interest, the recurring action patterns that constitute important and enduring organizational capabilities (Cohen et al., 1996).
- [2] The distinction is also referred to by other name-pairs such as the 'pragmatic and semantic systems' (Jeannerod, 1997), 'how' vs. 'what' (Goodale and Milner, 1992), 'where' vs. 'what' (Ungerleider and Mishkin, 1982), or the vision-for-action and vision-for-perception systems (Goodale and Westwood, 2004). For now, it seems prudent to stick to the anatomical designations, ventral/dorsal.
- [3] Many languages reflect this neuropsychological difference by maintaining two verbs for what English renders as 'to know'. Indeed, English once did so as well, when Old English distinguished *cnāwan* from *witan*, which have come down to the present in the verb 'to know' and the noun 'wits'.
- [4] A favourite story illustrating this point comes from Allison's (1971) account of the Cuban missile crisis. A shipload of Russian soldiers were told to avoid detection in the next day's landing at Havana by dressing in civilian clothes. They did this, but once on the dock they formed into neat ranks and marched away.
- [5] In recent years, highly-practiced surgical teams have implemented safeguards against their proneness to wrong-side surgery (Seiden and Barach, 2006).

REFERENCES

- Allison, G. T. (1971). *Essence of Decision: Explaining the Cuban Missile Crisis*. Boston, MA: Little, Brown and Company.
- Coello, Y., Richaud, S., Magnea, P. and Rossetti, Y. (2003). 'Vision for spatial perception and vision for action: a dissociation between the left–right and near–far dimensions'. *Neuropsychologia*, **41**, 622–33.
- Cohen, M. D. (2007). 'Reading Dewey: reflections on the study of routine'. *Organization Studies*, **28**, 773–86.
- Cohen, M. and Bacdayan, P. (1994). 'Organizational routines are stored as procedural memory: evidence from a laboratory study'. *Organization Science*, **5**, 554–68.
- Cohen, M. D., Burkhart, R., Dosi, G., Egidi, M., Marengo, L., Warglien, M. and Winter, S. (1996). 'Contemporary issues in research on routines and other recurring action patterns of organization'. *Industrial and Corporate Change*, **5**, 663–98.
- Custers, R. H. and Aarts, H. (2010). 'The unconscious will: how the pursuit of goals operates outside of conscious awareness'. *Science*, **329**, 47–50.
- Dosi, G., Nelson, R. R. and Winter, S. G. (Eds) (2000). *The Nature and Dynamics of Organisational Capabilities*. Oxford: Oxford University Press.
- Egidi, M. and Narduzzo, A. (1997). 'The emergence of path-dependent behaviors in cooperative contexts'. *International Journal of Industrial Organization*, **15**, 677–709.
- Everitt, B. J. and Robbins, T. W. (2005). 'Neural systems of reinforcement for drug addiction: from actions to habits to compulsion'. *Nature Neuroscience*, **8**, 1481–9.
- Farivar, R. (2009). 'Dorsal–ventral integration in object recognition'. *Brain Research Reviews*, **61**, 144–53.
- Feldman, M. S. and Pentland, B. T. (2003). 'Reconceptualizing organizational routines as a source of flexibility and change'. *Administrative Science Quarterly*, **48**, 94–121.
- Gibson, J. J. (1979). *The Ecological Approach to Visual Perception*. Boston, MA: Houghton Mifflin.
- Goodale, M. A. and Milner, D. A. (1992). 'Separate visual pathways for perception and action'. *Trends in Neurosciences*, **15**, 20–5.
- Goodale, M. A. and Westwood, D. A. (2004). 'An evolving view of duplex vision: separate but interacting cortical pathways for perception and action'. *Current Opinion in Neurobiology*, **14**, 203–11.
- Goodale, M. A., Meenan, J. P., Bühlhoff, H. H., Nicolle, D. A., Murphy, K. J. and Racicot, C. I. (1994). 'Separate neural pathways for the visual analysis of object shape in perception and prehension'. *Current Biology*, **4**, 604–10.

- Goodale, M. A., Westwood, D. A. and Milner, A. D. (2004). 'Two distinct modes of control for object directed action'. In Heywood, C. A., Milner, A. D. and Blakemore, C. (Eds), *Progress in Brain Research*, Vol. 144. Amsterdam: Elsevier, 131–46.
- Graybiel, A. M. (2008). 'Habits, rituals, and the evaluative brain'. *Annual Review of Neuroscience*, **31**, 359–87.
- Imamizu, H., Kuroda, T., Miyauchi, S., Yoshioka, T. and Kawato, M. (2003). 'Modular organization of internal models of tools in the human cerebellum'. *Proceedings of the National Academy of Sciences of the United States of America*, **100**, 5461–6.
- Jeannerod, M. (1997). *The Cognitive Neuroscience of Action*. London: Blackwell.
- Latour, B. (2005). *Reassembling the Social: An Introduction to Actor-Network-Theory*. Oxford: Oxford University Press.
- Milner, A. D. and Dyde, R. T. (2003). 'Orientation and disorientation: illusory perception and the real world'. In Johnson-Frey, S. H. (Ed.), *Taking Action: Cognitive Neuroscience Perspectives on Intentional Acts*. Cambridge, MA: MIT Press, 3–28.
- Milner, A. D. and Goodale, M. A. (1995). *The Visual Brain in Action*. Oxford: Oxford University Press.
- Mishkin, M., Malamut, B. and Bachevalier, J. (1984). 'Memories and habits: two neural systems'. In Lynch, G., McGaugh, J. L. and Weinberger, N. M. (Eds), *Neurobiology of Learning and Memory*. New York: The Guilford Press, 65–77.
- Neal, D. T. and Wood, W. (2008). 'Linking addictions to everyday habits and plans'. *Behavioral and Brain Sciences*, **31**, 455–6.
- Neal, D. T., Wood, W. and Quinn, J. M. (2006). 'Habits: a repeat performance'. *Current Directions in Psychological Science*, **15**, 198–202.
- Nelson, R. and Winter, S. (1982). *An Evolutionary Theory of Economic Change*. Cambridge, MA: Belknap Press of Harvard University.
- Norman, J. (2002). 'Two visual systems and two theories of perception: an attempt to reconcile the constructivist and ecological approaches'. *Behavioral and Brain Sciences*, **25**, 73–144.
- Pentland, B. T. and Feldman, M. S. (2008). 'Designing routines: on the folly of designing artifacts, while hoping for patterns of action'. *Information and Organization*, **18**, 235–50.
- Rangel, A. (2009). 'The neuroeconomics of simple goal-directed choice'. In Gazzaniga, M. (Ed.), *The Cognitive Neurosciences IV*. Cambridge, MA: MIT Press, 1075–84.
- Redish, A. D., Jensen, S. and Johnson, A. (2008). 'A unified framework for addiction: vulnerabilities in the decision process'. *Behavioral and Brain Sciences*, **31**, 415–87.
- Rizzolatti, G. and Sinigaglia, C. (2008). *Mirrors in the Brain – How Our Minds Share Actions and Emotions*, translated by Anderson, F., Oxford: Oxford University Press.
- Saur, D., Kreher, B. W., Schnell, S., Kümmerer, D., Kellmeyer, P., Vry, M.-S., et al. (2008). 'Ventral and dorsal pathways for language'. *Proceedings of the National Academy of Sciences of the United States of America*, **105**, 18035–40.
- Seiden, S. C. and Barach, P. (2006). 'Wrong-side/wrong-site, wrong-procedure, and wrong-patient adverse events: are they preventable?'. *Archives of Surgery*, **141**, 931–9.
- Simon, H. A. (1996). *The Sciences of the Artificial*, 3rd edition. Cambridge, MA: MIT Press.
- Singley, M. K. and Anderson, J. R. (1989). *The Transfer of Cognitive Skill*. Cambridge, MA: Harvard University Press.
- Squire, L. and Zola-Morgan, M. (1991). *Memory: From Mind to Molecules*. New York: Scientific American Library.
- Teece, D. J., Pisano, G. and Shuen, A. (1997). 'Dynamic capabilities and strategic management'. *Strategic Management Journal*, **18**, 509–33.
- Umiltà, M., Kohler, E., Gallese, V., Fogassi, L., Fadiga, L., Keysers, C. and Rizzolatti, G. (2001). 'I know what you are doing: a neurophysiological study'. *Neuron*, **31**, 155–65.
- Ungerleider, L. G. and Mishkin, M. (1982). 'Two cortical visual systems'. In Inge, D. J., Goodale, M. A. and Mansfield, R. J. W. (Eds), *Analysis of Visual Behavior*. Cambridge, MA: MIT Press, 549–86.
- Wang, J.-A. and Zhang, G. (2008). 'Knowledge, routines and performance in collective problem solving'. *Acta Psychologica Sinica*, **40**, 862–72.
- Warren, W. H. (2006). 'The dynamics of perception and action'. *Psychological Review*, **113**, 358–89.
- Yin, H. H. and Knowlton, B. J. (2006). 'The role of the basal ganglia in habit formation'. *Nature Reviews Neuroscience*, **7**, 464–76.