children. The *NF1* gene encodes neurofibromin, a RAS GTPase that converts the GTP-bound active form of RAS proteins to the inactive, guanosine diphosphate (GDP)-bound form (Scheffzek et al., 1997). As indicated in Figure 1, loss-of-function NF1 leads to hyperactivation of the RAF/MEK/ERK pathway and is associated with neurological diseases—notably low-grade astrocytomas. Studies by Gutmann and his colleagues demonstrate that NF1 inactivation promotes astroglial differentiation (Dasgupta and Gutmann, 2005). Moreover, deleting floxed *Nf1* in neural progenitors during early embryonic stages leads to a dramatic increase in the glia cell population in the brain (Hegedus et al., 2007)—a phenotype quite similar to that of the *caMek1/hGFAP* mice described by Li et al. (2012). Another very recent study by Zhu and his colleagues reveals that deletion of *Nf1* in neural stem cells results in increased gliogenesis at the expense of neurogenesis. Importantly, the NF1-mediated glia/neuronal fate switch is due to overactivation of MEK/ERK signaling, as it can be reversed by applying small molecule inhibitors of MEK/ERK function (Wang et al., 2012). The low-grade astrocytomas seen in NF1 patients have a sporadic counterpart in children. Recent studies show that a large majority of pediatric low-grade astrocytomas have activating mutations in BRAF (see Figure 1) (Jones et al., 2008; Pfister et al., 2008).

Closer to home for the basic scientists, the observations of Li et al. (2012) present a useful new tool to the field of glial biology. Postnatal functions of astrocytes have been difficult to resolve because it has been difficult to manipulate astrocyte number during development. Li et al. (2012) note that the *NestinCre Mek* null mice are acallosal at P0 in tandem with the absence of midline astroglia. Moreover, the *hGFAPCre Mek* null animals show a neurodegenerative phenotype by day P10. For the road ahead, the *Mek* ablation and *Mek* hyperactivation models described here may provide a means of changing neuron/glia ratios to display glial functions in neuronal activity. In the fullness of time, such manipulations might even shed light on the role of glia in the cognitive aspects of NF1 syndrome and a variety of other hereditary "RASothapies" associated with mutations in core components of the signaling axis.

REFERENCES

Barbacid, M. (1987). Annu. Rev. Biochem. *56*, 779–827.

Bos, J.L. (1989). Cancer Res. *49*, 4682–4689.

Dasgupta, B., and Gutmann, D.H. (2005). J. Neurosci. *25*, 5584–5594.

Ge, W.P., Miyawaki, A., Gage, F.H., Jan, Y.N., and Jan, L.Y. (2012). Nature *484*, 376–380.

Hegedus, B., Dasgupta, B., Shin, J.E., Emnett, R.J., Hart-Mahon, E.K., Elghazi, L., Bernal-Mizrachi, E., and Gutmann, D.H. (2007). Cell Stem Cell *1*, 443–457.

Jones, D.T., Kocialkowski, S., Liu, L., Pearson, D.M., Bäcklund, L.M., Ichimura, K., and Collins, V.P. (2008). Cancer Res. *68*, 8673–8677.

Li, X., Newbern, J., Wu, Y., Morgan-Smith, M., Zhong, J., Charron, J., and Snider, W. (2012). Neuron *75*, this issue, 1035–1050.

McCormick, F. (1993). Nature *363*, 15–16.

McKay, M.M., and Morrison, D.K. (2007). Oncogene *26*, 3113–3121.

Pfister, S., Janzarik, W.G., Remke, M., Ernst, A., Werft, W., Becker, N., Toedt, G., Wittmann, A., Kratz, C., Olbrich, H., et al. (2008). J. Clin. Invest. *118*, 1739–1749.

Robinson, D.R., Wu, Y.M., and Lin, S.F. (2000). Oncogene *19*, 5548–5557.

Scheffzek, K., Ahmadian, M.R., Kabsch, W., Wiesmüller, L., Lautwein, A., Schmitz, F., and Wittinghofer, A. (1997). Science *277*, 333–338.

Tidyman, W.E., and Rauen, K.A. (2009). Curr. Opin. Genet. Dev. *19*, 230–236.

Wang, Y., Kim, E., Wang, X., Novitch, B.G., Yoshikawa, K., Chang, L.S., and Zhu, Y. (2012). Cell *150*, 816–830.

Choosing for Me or Choosing for You: Value in Medial Prefrontal Cortex

Simon Dunne[1] and John P. O'Doherty[1,*]
[1]California Institute of Technology, Pasadena, CA 91125, USA
*Correspondence: jdoherty@caltech.edu
http://dx.doi.org/10.1016/j.neuron.2012.09.005

In this issue of *Neuron*, **Nicolle et al. (2012)** suggest that choice-related value signals in ventromedial and anterior dorsomedial prefrontal cortex can be distinguished by their relevance to the current choice, as opposed to their reflection of preferences ascribed to the self versus another.

Our understanding of the neural mechanisms of value-based decision making has increased dramatically in the last decade. Much of this progress has been achieved with the adoption of formal mathematical models that can be used to explain the process by which we compute values for stimuli in the world and use those values to guide our choices (Montague et al., 1996; Glimcher and Rustichini, 2004; Daw et al., 2005). By mapping components of these mathematical

models to neural activity (a technique called computational fMRI; O'Doherty et al., 2007), it has been possible not only to determine whether a region is engaged under a condition of interest, but also to make inferences about the nature of the computations being implemented. More recently, efforts have been made to expand the application of this method to choice problems with a social component (Hampton et al., 2008; Suzuki et al., 2012) These studies have reaffirmed the roles of key areas of prefrontal cortex such as dorsomedial prefrontal cortex (dmPFC), known previously to be engaged in tasks requiring social cognition (Amodio and Frith, 2006), and ventromedial prefrontal cortex (vmPFC), known to be involved in value-based choice (Hare et al., 2008). But, more importantly, such studies are beginning to yield insights into the specific components of the choice processes in which these areas are implicated. In a new study published in the current issue of *Neuron*, Nicolle et al. (2012) used computational fMRI to investigate whether the neural substrates of value are sensitive to the distinction between actions evaluated based on their direct value to the self and those evaluated based on their value to others.

In the task design in Nicolle et al. (2012), subjects made a choice on each trial between receiving a small monetary prize that would be delivered following a short delay or a larger prize that would be received following a longer delay, with the magnitudes and delays varying across trials. Crucially, trials differed in that on some, the subject chose between the prizes based on their own preferences, while on others they made choices on behalf of a partner, whose preferences they had learned in a training session before beginning the task. Subjects were paired with partners whose preferences for the balance between prize magnitude and delay were dissimilar to their own, which enabled the authors to determine that subjects were truly making choices for their partner based on the partner's preferences. The authors used the choices made by each of the subjects during the task to fit a temporal discounting model, which allowed them to estimate for each trial both the valuations subjects held for the prizes ("self values") and the valuations for the prizes the subject ascribed to their partner ("partner values"). The sets of choices presented to the subjects were constructed such that the correlation between the self and partner values of the available prizes were minimized, allowing the authors to separately examine the neural correlates of each. The time series of the self and partner values were regressed against fMRI data that were acquired while the subjects made their choices in order to test for regions with corresponding response profiles.

Accumulating evidence suggests that the vmPFC plays a key role in "model-based" reinforcement learning, in which the value of decision options is computed with reference to a rich internal model of the states of the decision problem and the reward values of these states (or "state space") (Hampton et al., 2006; Daw et al., 2011). Accordingly, the value of options can be updated instantaneously in a model-based framework based on knowledge about changes in the structure of the world, such as, for example, a change in the subjective value of the goal state (Valentin et al., 2007), or a change in the transitions between states reached following specific actions (Hampton et al., 2006). Here, Nicolle et al. (2012) found that, when participants were asked to choose for themselves, activity in vmPFC reflected valuation signals corresponding to the relative values assigned to the options based on their own subjective preferences, consistent with the findings of a number of previous studies (Boorman et al., 2009; FitzGerald et al., 2009). However, much more intriguing was the finding that, in trials in which the subjects made choices on behalf of their partners, vmPFC no longer responded to the self values, but instead responded to the partner values; that is, activity in vmPFC reflected not their own preferences, but rather those of their partner. Within the context of a role for this region in model-based computations, the findings by Nicolle et al. starkly demonstrate just how flexible the value computations in this region are: not only does vmPFC reflect valuation based on one's own preferences when those are needed to guide choice, but the same region can also reflect the preferences of another person when those preferences are relevant to the choice process.

In addition to the valuation signals noted in vmPFC, Nicolle et al. also report a striking pattern of value-related BOLD activation in dmPFC. Specifically, on trials in which the subjects made choices on behalf of their partners, dmPFC responded to the difference in the self value for the two available prizes, while in trials in which subjects chose for themselves, dmPFC responded to the difference in their partner values. It is interesting to note that the self- versus other-oriented distinction was not reflected in the neural activations in either dmPFC or vmPFC. That is, although one value signal reflected the subjects' own preferences for discounting and the other, arguably more social, value signal reflected the preferences subjects attributed to their partners, each was encoded in vmPFC when relevant for choice and in dmPFC when it was not. The pattern of dmPFC activations is particularly surprising in this regard, given the role commonly attributed to the region in supporting social cognition (Amodio and Frith, 2006). In particular, the ability to "mentalize," or to attribute intentions, beliefs, and other mental states to other agents is consistently associated with activation of this region across fMRI and PET studies (Frith and Frith, 2003). However, the present results suggest that anterior dmPFC in the present task may not necessarily be "social" at all, but instead might facilitate the simulation of signals that are currently not relevant for choice, regardless of whether those signals correspond to representations about the self or another person. Such an interpretation conforms to theories of dmPFC function that claim that its critical role lies in the creation of representations of the world that are decoupled from the sensory environment (Frith and Frith, 2003). Such a computational process could still underlie social inferences by allowing for the simulation of other agents, but importantly, its functional remit is not limited to social contexts, but rather to any situation in which simulation of events divorced from the sensory environment is required.

The above-mentioned interpretation of the dmPFC findings raises an interesting question: Why are these value signals in dmPFC being computed in the first place? The presence of these activations is

somewhat surprising in the task used by Nicolle et al., because the respective variables they represent are, at least superficially, irrelevant to the choice at hand. One possibility is that the representation of the valuations according to the alternative preference set in dmPFC corresponds to their storage in a temporary buffer. In the event of a change of decision context, those signals can be immediately transferred into vmPFC, permitting rapid deployment of the now behaviorally relevant preference set. Another possibility is that (although not applicable in the specific task used by Nicolle et al., 2012), the representation of the alternative valuations in dmPFC may allow for the ongoing updating of those model-based value signals on the basis of new information about the sensory environment as it is received.

The study by Nicolle et al. invites several important directions for further research going forward. First of all, if "other" versus "self" is not the relevant dimension for differentiating ventromedial versus anterior dorsomedial prefrontal function, but instead the distinction is between the choice relevance of alternative state-space models, one might expect a similar pattern of results in a task involving switching between two state-space models, even in a completely nonsocial context. Second, if it is the case that the dmPFC is acting as a buffer to store alternative models of the decision problem at hand to enable rapid transferring of choice-relevant models into vmPFC, what happens in the dmPFC if more than two such frameworks are to be used for a given task, such as, for example, if participants had to make choices on behalf of two other people as well as themselves? Regardless of the outcome of such future research, the study by Nicolle et al. illustrates how, through the use of quantitative computational approaches married to dynamic measurements of brain function, it is possible to gain insight into the specific computational functions of brain regions involved in even the most complex social-cognitive processes.

REFERENCES

Amodio, D.M., and Frith, C.D. (2006). Nat. Rev. Neurosci. *7*, 268–277.

Boorman, E.D., Behrens, T.E.J., Woolrich, M.W., and Rushworth, M.F.S. (2009). Neuron *62*, 733–743.

Daw, N.D., Niv, Y., and Dayan, P. (2005). Nat. Neurosci. *8*, 1704–1711.

Daw, N.D., Gershman, S.J., Seymour, B., Dayan, P., and Dolan, R.J. (2011). Neuron *69*, 1204–1215.

FitzGerald, T.H.B., Seymour, B., and Dolan, R.J. (2009). J. Neurosci. *29*, 8388–8395.

Frith, U., and Frith, C.D. (2003). Philos. Trans. R. Soc. Lond. B Biol. Sci. *358*, 459–473.

Glimcher, P.W., and Rustichini, A. (2004). Science *306*, 447–452.

Hampton, A.N., Bossaerts, P., and O'Doherty, J.P. (2006). J. Neurosci. *26*, 8360–8367.

Hampton, A.N., Bossaerts, P., and O'Doherty, J.P. (2008). Proc. Natl. Acad. Sci. USA *105*, 6741–6746.

Hare, T.A., O'Doherty, J., Camerer, C.F., Schultz, W., and Rangel, A. (2008). J. Neurosci. *28*, 5623–5630.

Montague, P.R., Dayan, P., and Sejnowski, T.J. (1996). J. Neurosci. *16*, 1936–1947.

Nicolle, A., Klein Flugge, M.C., Hunt, L.T., Vlaev, I., Dolan, R.J., and Behrens, T. (2012). Neuron *75*, this issue, 1114–1121.

O'Doherty, J.P., Hampton, A., and Kim, H. (2007). Ann. N Y Acad. Sci. *1104*, 35–53.

Suzuki, S., Harasawa, N., Ueno, K., Gardner, J.L., Ichinohe, N., Haruno, M., Cheng, K., and Nakahara, H. (2012). Neuron *74*, 1125–1137.

Valentin, V.V., Dickinson, A., and O'Doherty, J.P. (2007). J. Neurosci. *27*, 4019–4026.

Attending to the Present When Remembering the Past

Brice A. Kuhl[1,*] and Marvin M. Chun[2,3,*]
[1]Department of Psychology, New York University, New York, NY 10003, USA
[2]Department of Psychology, Yale University, New Haven, CT 06520, USA
[3]Department of Neurobiology, Yale University, New Haven, CT 06520, USA
*Correspondence: brice.kuhl@nyu.edu (B.A.K.), marvin.chun@yale.edu (M.M.C.)
http://dx.doi.org/10.1016/j.neuron.2012.09.002

In this issue of *Neuron*, Guerin et al. (2012) provide novel evidence that distinct parietal mechanisms for attention and memory compete when past experiences are compared to current perceptual input. While dorsal parietal cortex supports attention to perceptual stimuli, high attentional demands suppress ventral parietal regions important for veridical remembering.

When walking down a street, sitting in a restaurant, or boarding a plane, we often find our attention captured by a person that looks like someone we know. We find ourselves wondering: *do I know this person?* In these situations, we focus on perceptual features of this candidate acquaintance and compare these perceived features to our internal representation (memory) of the neighbor, colleague, or relation that they resemble. Through this process we may determine that this person *is not* a person we know (in which case we would likely opt to not wave or say hello) or that this person *is* someone we know (in which case we may still find ourselves debating whether the situation permits a wave or hello).