

Cognitive Neurosciences and Strategic Management: Challenges and Opportunities in Tying the Knot

**Authors and affiliations:**

Daniella LAUREIRO MARTINEZ\* ETH Zurich, Switzerland.

Vinod VENKATRAMAN\* Fox School of Business, Temple University, Philadelphia, United States.

Stefano CAPPÀ IUSS Center for Neurocognition and Theoretical Syntax, Pavia University, Pavia, Italy.

Maurizio ZOLLO Bocconi University, Milan, Italy.

Stefano BRUSONI ETH Zurich, Switzerland.

\*first and corresponding authors – equal contribution

Working Paper – Do Not Cite Without Author's Permission

**Running head:**

Cognitive Neurosciences and Strategic Management

## Structured Abstract

Conceptual paper

Purpose

This paper discusses the practical challenges and opportunities involved in merging the two fields of cognitive neurosciences and strategic management, starting from the premise that the need to marry them is justified by their complementarities, as opposed to the level of analysis on which they both focus.

Design/methodology/approach

We discuss the potential benefits and drawbacks of using methods borrowed from cognitive neurosciences for management research.

Findings

First, we argue that there are clear advantages in deploying techniques that enable researchers to observe processes and variables that are central to management research, with the caveat that neuroscientific methods and techniques are not general-purpose technologies. Second, we identify three core issues that specify the boundaries within which management scholars can usefully deploy such methods. Third, we propose a possible research agenda with various areas of synergy between the complementary capabilities of management and neuroscience scholars, aiming to generate valuable knowledge and insight for both disciplines and also for society as a whole.

Originality/value

By focusing on the practical issues associated with the use of neurosciences to answer

managerially relevant questions, we hope to help researchers design appropriate research efforts to take the opportunities while avoiding the pitfalls inherent in this specific type of cross-disciplinary endeavor.

Keywords: neuroscience, cognition, decision-making, attention, sustainability, fMRI, methods, opportunities, challenges

# **Cognitive Neurosciences and Strategic Management: Challenges and Opportunities in Tying the Knot**

Daniella LAUREIRO MARTINEZ\*, Vinod VENKATRAMAN\*,

Stefano CAPPÀ, Maurizio ZOLLO, Stefano BRUSONI

\*first and corresponding authors – equal contribution

## **Abstract**

This paper discusses the potential benefits and drawbacks of using methods borrowed from cognitive neurosciences for management research. Its aim is threefold. First, we argue that there are clear advantages in deploying techniques that enable researchers to observe processes and variables that are central to management research (e.g. cognition, attention, emotions). However, we should not allow ourselves to be carried away by “neuro-hype.” Neuroscientific methods and techniques (e.g. fMRI) are not panaceas; they are useful for solving some specific types of problems, but not all. Second, we identify three core issues that determine the boundaries within which management scholars can usefully deploy such methods: task selection and replication, sampling considerations, and ethical implications. Each of these issues presents threats and opportunities that researchers need to consider. Finally, we propose a possible research agenda that identifies various areas of complementarity between strategic management and neuroscience, aiming to generate knowledge and insight for both academic communities, and also for society as a whole.

## **Introduction**

The rise of behavioral strategy as a means to further the quest for appropriate microfoundations to management research has driven the diffusion of new methods for collecting and analyzing new types of data. This paper provides a critical discussion and evaluation of the possibility of adapting neuroscientific techniques to understand managerial decision-making, its antecedents, and its deep processes. Issues of cognition and learning are central to discussions on strategy (Gavetti, Levinthal, & Ocasio, 2007; Levinthal, 2011). Therefore, bringing in cognitive neurosciences seems an obvious extension to what management scholars already do. In this paper, we contend that the use of neuroscientific techniques can play an important role in informing management research and work on behavioral strategy.

Scholars have speculated that management research requires the use of neuroscience to study decision-making at the individual level, since strategy research deals with important, often irreversible decisions taken by key individuals (Becker, Cropanzano, & Sanfey, 2011; Powell, 2011). However, we contend that the individual level of analysis is not the point. There are several managerially relevant problems occurring at the individual level that do not require neuroscience techniques; individuals can be studied perfectly well using the numerous management-science methods already available. Instead, we argue that strategy needs cognitive neurosciences in order to benefit from that field's theories and findings, and to add its techniques to the pool of extant management-science methods. Theories and findings from cognitive neuroscience could serve as building blocks for the study of important management issues, since it has been established that cognition and learning are central to strategy. Using cognitive neurosciences techniques would allow for greater precision, reliability, and cumulativeness in the analysis of certain types of problem.

However, applying these techniques poses several challenges. Researchers should use caution, and be mindful not only of the basic philosophical differences between management and neuroscience (Healey & Hodgkinson, 2014), but also of the crucial methodological and design issues they will face. We aim to clarify the types of problems that would benefit from the incorporation of neuroscientific methods in management research, and offer suggestions for doing so successfully.

We begin by briefly introducing one of the most common cognitive neurosciences techniques: functional magnetic resonance imaging (fMRI). We propose three steps for the use of neuroscientific methods to address strategic management questions. Unlike other discussions on this topic, we take a highly pragmatic approach, focusing on three specific design issues to be considered. In our view, we already know a lot about the general issues related to applying these techniques (e.g. methodological individualism, the danger of reductionism, reverse causality, etc.). All these challenges can be addressed, but to do so we must look at the detail, wherein hides the devil. The heart of this paper is therefore structured around three central methodological and design issues that must be tackled in order to apply neuroscientific techniques in management research: task design, sampling processes, and ethical implications and underpinnings. We thus clarify the features that scholars should consider when deciding whether to use these methods for management research. We conclude by proposing a research agenda for management scholars and neuroscientists interested in advancing the discussion on cognition and decision-making.

### **fMRI as a method for strategic management research**

Several methods are available to study and understand neurological and physiological mechanisms of potential interest to social science in general, and management science in particular. They include EEG, MEG, PET, GSR, and fMRI, among many others. In this piece, we focus mainly on fMRI because of its current popularity and strong potential for informing

mechanistic questions in strategic management.

fMRI is a non-invasive method that enables investigators to localize and track changes in blood oxygenation during ongoing cognitive tasks (Ogawa et al., 1990). The popular blood oxygenation level dependent (BOLD) contrast, used to measure brain activity, is based on the fact that hemoglobin has different magnetic properties depending on its state of oxygenation: oxyhemoglobin is diamagnetic, while deoxyhemoglobin is paramagnetic, and paramagnetic substances distort the surrounding magnetic field more. When a particular task engages specific regions in the brain, the brain vasculature responds by increasing the flow of oxygen-rich blood into those regions. This in turn, leads to a localized increase in BOLD signal intensity in that brain region, which is measured using high-field magnetic resonance scanners (Huettel, Song, & McCarthy, 2004). Thus, the BOLD signal represents an indirect and correlative measure of local neuronal activity.

The typical fMRI response to a single trial or event, known as the hemodynamic response, begins after a delay of 1–2 seconds, peaks about 5–6 seconds after the onset of the event, and returns to the baseline (default activation prior to onset of the event) roughly 14–16 seconds from event onset. The measurement of hemodynamic response can be confounded by several sources of noise, including machine noise, random white noise, and artifacts such as breathing and heartbeat, among others. Therefore, several trials are needed to reliably isolate task-related hemodynamic response from noise. Crucially, the hemodynamic responses to multiple sequential events sum in a roughly linear manner (Dale & Buckner, 1997; Huettel & McCarthy, 2000), which allows multiple events to be presented at greater frequency than the 14–16-second duration of a single hemodynamic response.

Despite their many advantages in terms of localizing brain activity, fMRI studies still provide only an indirect and correlative measure of underlying neuronal activity. It is not possible to

attribute causality: the activated regions may be associated with the task, but are not necessarily essential for it. Also, multiple sampling iterations (i.e. multiple task trials) are required to obtain reliable estimates for each phenomenon of interest. This is particularly relevant in management and strategy studies, where researchers need to obtain choice preferences across multiple problems to achieve reliable neural estimates (a theme we will return to later).

Therefore, we propose three key steps that management scholars considering using fMRI techniques to answer questions about strategic management should take:

1. **Simplify the real-world strategy problem into a cognitive neuroscience-friendly format.** This includes devising repeatable tasks that can be presented sequentially such that neural correlates for each cognitive process of interest can be isolated experimentally. For example, if you study market-entry decisions, you need to make sure that specific decision situations that target precisely the study question are presented a large number of times to the study participants repeatedly. It is common to present participant with the decisions over a hundred trials. If one has two types of decisions (say new and old markets), it will be common to have well over two hundred decision trials, with similar choice alternatives each time, so that a decisional pattern can be established and the neural correlates statistically validated vis-à-vis other possible stimuli or noise signals.
2. **Identify the neural correlates of the variables believed to predict preferences.** Based on prior literature in neuroscience, the research team (typically made up of both strategy and neuroscience scholars) will need to specify not only the theoretical variables in the decision model, but also the neural location of each factor in the model. For instance, Laureiro et al. (2010) show the neural correlates of the exploration and exploitation decisions of interest in

their study, based on advancements in neuroscience that refer to similar factors<sup>1</sup>. This step allows robust models of behavior to be built that are biologically plausible, based on the neural correlates identified. However, while identifying neural correlates may be of interest to neuroscientists, management researchers are more concerned with building reliable models of behavior that can predict subsequent out-of-sample behavior (Venkatraman, Clithero, Fitzsimons, & Huettel, 2012) – and this has some ethical implications, as discussed below.

3. **Give participants real incentives to engage fully in the task.** Given the repetitive nature of the tasks typically used in cognitive neuroscience lab studies, it is important to incentivize participants in order to maintain their engagement and obtain their true underlying preferences. This is standard practice in well-designed experiments, but becomes particularly important when the objective is to detect neural activations of interest, disentangling them from other possible signals produced by the brain. For similar reasons, it is also particularly important to select a homogenous sample to obtain robust and meaningful inferences.

### **Three central issues: task selection and replication, sampling considerations, and ethical implications**

The three steps above are centered on three crucial practical issues – task selection, sampling, and ethical issues – that must be clearly understood for a successful marriage between cognitive neurosciences and strategic management. In this section, we discuss these issues and briefly address the key threats and opportunities inherent in each one.

---

<sup>1</sup> This step might lead to a conceptual/methodological contribution for the strategy field, as an intermediate step towards the publication of the results of the empirical inquiry.

### ***Task selection and replication***

When we think of “strategy” problems, we think of big decisions relating to major initiatives such as alliances, reorganizations, R&D investments, product launches, etc. Such situations involve complex and infrequent decisions that have irreversible results (Loasby, 1976). Some believe that neuroscience can take us “inside the heads” of the business leaders who make these decisions, but this belief is unfounded. The brain is a notoriously complex organ that performs several different functions simultaneously. For example, how do we isolate activations related to negotiating a strategic alliance from an intervening background thought about what time to have lunch? The usual approach adopted in neuroscience to tackle this fundamental issue is to design experiments that require multiple iterations of the core task (e.g. alliance design) to reliably isolate activations related to the process of interest. Crucially, these iterations need to be designed such that the participants remain engaged with the process, even as they make very similar decisions over and over again. Given these constraints, we should also consider whether deploying such expensive techniques really makes sense for management scholars. We contend that progress needs to be in small steps rather than giant leaps.

First, the management tasks used for neuroscience studies must be simple and repeatable. The design challenge is to identify the core elements of a complex business decision so the participant can carry out a simple task while in the fMRI scanner. For example, if we want to study how individual managers make decisions related to M&A processes, we need to specify precisely which decision we want to explain, and what are its cognitive or emotional antecedents. Let’s say we want to study how managers decide whether the top management team of the acquired company should be retained or replaced. We need to create a (simulated) scenario in which this decision is made several times, perhaps in different situations. The differences between situations should be theoretically meaningful for the experimental manipulation – so, for instance, they might relate to

the performance of the acquired company, its size, its product relatedness, or its geographic location. But the focal decision must always be the same, sufficiently simple and clear, and related to specific cognitive and rational drivers that can be isolated from the myriad neural systems that could potentially be activated when a decision to replace or retain the acquired top management team is made.

In another example, if the problem is framed in terms of trust, we might implement a multi-round version of a modified dictator game called the “trust game” (King-Casas et al., 2005). In each round, subjects make decisions about whether or not to trust their investments to different individuals, based on their profiles. The use of different profiles across different rounds allows the decision to be repeated while keeping the participant engaged and interested. However, use of the trust game precludes any discussion about risk, which would require a different task (Huettel, Stowe, Gordon, Warner, & Platt, 2006; Venkatraman, Payne, Bettman, Luce, & Huettel, 2009). It is also possible to use a combination of tasks to isolate the specific underlying processes and mechanisms (Venkatraman, Rosati, Taren, & Huettel, 2009).

A good starting point for management researchers who want to identify appropriate tasks is to try to understand how neuroscientists approach these problems. Initially, neuroscientists rely on, and control for, a relatively large range of empirical regularities that generally hold true. For example, it is commonly accepted that there is a strong positive correlation between measures of intelligence and performance in the working memory (N-back) task, where participants are presented with a series of letters from the alphabet and asked to indicate whether the current stimulus matches the one presented “N” trials back. Hence, it is possible to design tasks that ignore IQ results if they include controls such as N-back. There are few tasks in the context of management research that are of comparable robustness and regularity, particularly at the individual level.

### *Sampling considerations*

It is important to observe that (theoretical) sampling decisions are related to the choice of processes to observe in an organization, and understanding how to select the relevant processes to observe in a neuroscientific study is crucial.

A large multinational corporation is likely to include managers who are diverse in terms of their culture, educational background, age, and gender. If we are interested in studying the neural correlates of their decision-making outcomes, we need to pay particular attention to the size and homogeneity of the sample.

In terms of sample size, most fMRI studies involve relatively small samples of 15 to 20 participants (Yarkoni & Braver, 2010). The two main reasons for this are the complexity of conducting the studies and the costs per participant. The primary aim of these studies is to understand consistent activations across the sample – that is, the epistemological focus is on the location and magnitude of the mean effect (neural activation) of a given decision or action, rather than explaining the variance in behavioral or performance outcomes across the sample. For example, in a neuroscientific study of risk, the primary objective is to identify the regions of the brain that are consistently associated with risky decisions.

Some recent work has used slightly bigger samples (30 individuals) to try and understand individual variability (Laureiro-Martínez et al., 2014; Venkatraman, Huettel, Chuah, Payne, & Chee, 2011; Venkatraman, Payne, et al., 2009). In this research, the emphasis is on understanding how individual differences in risk propensity lead to modulation of activity in the brain regions associated with risk processing. If we can isolate these regions reliably, it is conceivable that these measures could be used as reliable indices to predict performance in different management scenarios. This raises several ethical concerns, which are discussed in the next section.

A third class of studies seeks to understand differences between two groups of individuals.

This is similar to patient and clinical studies in neuroscience, which involve people with various disorders (Korn, Sharot, Walter, Heekeren, & Dolan, 2014; Schlagenhaut et al., 2014). In these studies, a separate homogenous group of individuals with a specific disorder is often compared to a closely matched cohort of healthy individuals to identify differences in activations and develop possible interventions. Individuals are matched on a series of variables that the researchers want to control for; age and gender are used in many cases.

Similar paradigms can be extended to management problems where two groups of “healthy” individuals are compared against each other, using specific performance metrics to rank them. However, these metrics are often subjective and complex to develop. Therefore, the sampling techniques used in typical neuroscience experiments are closer to theoretical sampling than statistical sampling, and the emphasis is often on experimental control and comparability rather than representativeness.

Identifying the specific categories with which to replicate a certain phenomenon/outcome in healthy individuals is very similar to the logic deployed in case-study research where participants are identified to exclude trivial explanations and guarantee comparability of results (Eisenhardt & Graebner, 2007; Yin, 2010). At this stage of technological development of fMRI research, the samples will necessarily be small. In our view, it is important that the management community tackles this issue, in order to understand what can be gained from using these methods. There is a need for precision and observability (hence the relevance of the comparison with qualitative methods), with less interest in generalizability and external validity.

This discussion of sample sizes and sampling techniques highlights a dilemma related to the homogeneity of the sample. Based on the last 10 years of neuroscience and psychological research, we know that factors such as age, gender, education, and language have significant impacts on psychological processes and neural activations. For example, there is considerable evidence that

aging alters the patterns of brain activity associated with many cognitive tasks, even if we only consider healthy individuals (Cabeza, 2002). Most of the evidence derives from memory studies, which generally involve greater activation of a broader set of brain regions associated with comparable levels of performance (for a comprehensive review, see Rossini, Rossi, Babiloni, & Polich, 2007). This is often taken to indicate “compensatory” engagement of more brain tissue to counteract the effect of neuronal cell loss associated with aging. Similarly, the impact of education and occupation derives mostly from clinical or neuropsychological studies that assess the role of cognitive reserves as a factor of resilience to counteract advancing neurodegenerative pathology (see, e.g. Garibotto et al., 2008). Many studies report gender differences in brain activity in relation to women showing more bilateral activity than men in language-processing tasks (however, see the negative results of the meta-analysis reported by Sommer, Aleman, Bouma, & Kahn, 2004). More reliable differences have been reported in the domain of emotional processing (see, e.g., Schulte-Ruther, Markowitsch, Shah, Fink, & Piefke, 2008), especially in relation to subjects’ personality traits and genetic background (Brown & Hariri, 2006). Finally, linguistic background (monolingual vs. bi- or multilingual) is an important modulator of brain activity in tasks that engage language processing (see review in Abutalebi, Cappa, & Perani, 2001).

Given the range of variability across demographics, the classic neuroscientific response is often to exclude people with certain characteristics from the sample (i.e., to choose a more homogenous sample). The key objective of many neuroscience experiments is understanding how the brain works under normal circumstances, with normality grounded mainly in how often individuals with certain traits appear in the population. These criteria might appear odd to management scholars: variables such as age, which is often correlated with experience and tenure, are clearly important to them. On the other hand, it is far less intuitive for management scholars to make sense of individual differences such as bilingualism. For instance, one would expect

bilinguals to be highly represented in large multinationals – should we exclude them from our studies since we expect differences in brain activation?

We conclude our discussion on sampling by highlighting the crucial distinction between *structural* and *functional* differences in brain activations. In the case of aging, many of the differences observed may be due to structural changes such as brain atrophy associated with age. Alternatively, the differences in brain activations may represent systematic differences in the way people approach a particular problem – i.e. functional differences. While structural changes may be of greater concern from a sampling perspective, especially when using smaller samples, we contend that functional differences can and should be exploited more in management research. For example, if we know that two different firms approach the same problem from different perspectives, one of which leads to better results and more effective decisions, this is something to learn from. However, a more heterogeneous sample requires a larger sample size, and hence higher costs. The dilemma between using homogeneous (excluding participants who may be outliers to the problems of interest) versus heterogeneous samples raises other ethical concerns.

### ***Ethical implications***

In this section we identify four major ethical issues associated with the application of cognitive neuroscience methods to management research.

#### **Abnormalities**

The first issue relates to the appearance of physical abnormalities in brain scans. Approximately 1% of individuals have brain abnormalities, which raises at least two ethical implications. Firstly, since most of these abnormalities are discovered after data collection, we need to address the issue of “incidental” findings. In most cases, study participants are unaware of any abnormalities, and the researchers are rarely qualified to make diagnostic inferences. So do they have a moral

obligation to advise the participant to seek further advice? The answer depends on whether, prior to the scan, the researcher obtained the participant's agreement to be contacted in the case of unexpected results. Another key question is whether the researchers involved are trained in coping with emotional situations in a rational and effective manner. If not, should all scans include clinical oversight by trained physicians?

The second issue is related to whether data on individuals with abnormalities should be included in the subsequent analyses. As discussed in the section on sampling, what is critical is whether the research question focuses on understanding individual differences. If the interest is in aggregate performance, it might be better to preserve a tightly homogenous sample and exclude individuals with abnormalities. Here, we should emphasize the similarities with qualitative research, which traditionally focuses on studying unique events and organizations.

## **Resources**

The second ethical issue relates to the resources required to perform an fMRI study, and the opportunity costs of accessing them. This issue has three dimensions: the opportunity cost of the fMRI laboratory, the total opportunity cost of the study, and the opportunity cost of participants.

1. **Laboratory-related opportunity costs.** Studying 18 managers using fMRI occupies the scanner facilities, as well as its attendant technicians, for at least 18 to 25 hours, during which they might otherwise be used to care for patients. To mitigate this issue, it may be possible for a study of managers to involve researchers interested in various other questions – and individuals – that could be synergistically transformed. One solution would be to coordinate scanner access to coincide with times that are unlikely to be useful to patients – for example, outside clinicians' working hours, or during other periods when the facilities are not available for patient use. It might be that these times would also suit the populations of interest to strategic management

researchers, and avoid clashes with normal working hours.

2. **Study costs.** One might wonder about the costs of an fMRI study. While prices vary across different laboratories from less than hundred to several hundreds of dollars, the total cost will depend mainly upon the agreements made between the researchers and the specific lab. As with other techniques, researchers must consider not just the total cost of performing the study, but also whether the technique is the most appropriate to address the research question. To continue the comparison with qualitative techniques, the cost of using a scanner for an fMRI study is comparable to the costs of in-depth parallel case studies that include travel costs, interview costs, transcription costs, software for analysis, and so on.
3. **Participants' opportunity cost.** Unlike patients taking part in medical research, management study participants are often volunteers who are willing to give up their time out of the motivation to collaborate with the researchers, at the expense of devoting that time to their work or personal lives. In particular, the subjects of strategic management studies may hold very senior managerial positions and have very busy work schedules, making the opportunity cost of their time very high. Researchers should discuss what can be done to encourage participants to join the study, and, most importantly, keep them motivated during the tasks, especially if the design includes randomized controlled trials with interventions occurring between a baseline and a post-intervention data collection round. The possibilities will vary, and depend greatly on the researcher's understanding of the sample population. Offering payment to offset participants' opportunity costs might not be feasible, and researchers will probably have to rely on non-monetary incentives such as sharing the study results with participants, or giving them personalized feedback on how

their results compare to the rest of the sample and/or the broader population.

### **Generalizability**

The third ethical implication derives from the fact that the brain responses that constitute the results of fMRI studies are obtained from a small group of subjects and then generalized to larger populations. Management is inherently normative, while cognitive neuroscience is descriptive, which poses a challenge. Our findings might be used to advise organizations about how to increase their profits, and this may be at the expense of the individual participating in the study, or others like them. As management scholars, what should we do when we identify a key neural correlate and this finding is used to select, hire, or promote certain people at the expense of others? Does this constitute selection, or discrimination? In our view, it is selection if the individual can train and deliberately improve performance in the brain systems identified as relevant for predicting performance, but discrimination if they cannot. We know that some brain systems are plastic, even in adults, while others are less so. So the system of interest is an ethical design choice that is made before embarking on the study; relegating ethical issues to the end of the study is unethical since the choices are irreversible.

### **Neuro-hype**

Finally, it is important to bear in mind that coverage of neuroscience studies in the popular media tends to make a phenomenon seem real, objective, or effective to the public merely because it involve activation of the brain – a concept termed “neuro-realism” (Racine, Bar-Ilan, & Illes, 2005). Neuro-realism refers to the uncritical way in which the findings of neuroscientific investigations are seized upon as validating (or invalidating) our worldview. It is based on the naïve argument that “if the brain says so, it must be true,” and is grounded in the belief that the colorful blobs on an fMRI scan represent “visual proof” of the underlying brain processes,

regardless of the huge complexity of data acquisition and analysis. Thus, such media reporting raises ethical issues about the way neuroscience findings are disseminated, especially to the general public. Additional considerations include the basic implications of gaining knowledge based on a better understanding of how our brains work. For example, the Human Brain Project (HBP) devotes 3% of its budget to its Ethics and Society Program, whose goals include debating social and ethical issues among HBP researchers and stakeholders more widely.

We should also take account of learning from other fields, such as genetics. By contemporaneously considering the various issues in proactive, multidisciplinary dialogue, we should be able to develop more acceptable and relevant standards than if we allow them to emerge later through external processes. Finally, disciplines and roles other than researchers – policy makers, lawyers, journalists, and most importantly, organizational leaders and managers – need to be involved in the discussion to represent the broader public. There is a common misconception that ethics discussions should be reserved for philosophers; we believe everyone should play an active role.

### **Cognitive neuroscience and strategic management: the road ahead**

So far, our discussion has dwelt on things that we, as management scholars, should not do, or don't know how to do. We would now like to turn that on its head, and argue that by recognizing our current limitations, and the persistent tensions in our situation, we can actually move forward quickly and safely. The points here are not exhaustive; rather, they are intended to hint at the array of possibilities that lie ahead of us.

First, neuroscience methods can enable and oblige us to clarify what we mean by strategy. If strategy is seen as something that is continuously formulated, bottom-up, and adapted in response to environmental circumstances – that is, very much in line with behavioral approaches (as in e.g.

Cohen, 2007; Cyert & March, 1963; Foss, Heimeriks, Winter, & Zollo, 2012; Gavetti & Rivkin, 2007; Levinthal, 2011; Winter, 2013) – then we are all on common ground. However, if strategy is understood as one-off, top-down decision-making (Ansoff, 1980, 1987) then there is a conflict. The value of neuroscience for management research lies in the opportunity to closely examine the decisions made by managers in relevant, albeit simulated, contexts, employing a behavioral lens. In other words, neuroscience and its methodologies should not be employed because managers are individuals, and hence can be “studied.” They should be used because we believe that over the long term, big strategic decisions comprise a series of small, repeatable decisions, and that issues and processes related to experience and learning matter. If we share this belief, the next step is to design a task that captures these small decisions in an incentive-compatible manner, to be studied using brain imaging.

Second, an alternative way to use neuroscience in strategic management research is to measure individual-level *antecedents* to strategic decision-making, and, indirectly, performance outcomes. In other words, brain imaging can provide objective and extremely precise measurements of how individual managers’ brains activate in the presence of a given stimulus – not just while they are making a specific decision, or carrying out a strategically relevant action. For example, if one studies cooperative strategies, it might be particularly relevant to gauge managers’ strength of empathic reactions to a standard set of stimuli (e.g. vignettes, pictures, short movies, etc.) to explain variation in, say, design decisions (e.g. equity or governance arrangements) or even in alliance performance. Compared to the alternative of relying on self-reported assessments, or even psychological scales, the objectivity and precision of brain imaging techniques can be a particularly strong advantage in a study design. Incidentally, one advantage of using brain imaging techniques together with standard scales to measure a given construct lies in testing the capacity of psychological scales to capture the variance in the same theoretical constructs. Once the scales had

been validated via correlational evidence with neural correlates, it would be possible to simplify future research designs that make use of them, especially for control measures.

A third area of contribution relates to the study of learning and capability building processes. In this case, the advantage offered by neuroscientific methodologies, and related bodies of knowledge, lies in the objective and quantitative assessment of learning. Here, the phenomenon of learning is defined as the variation of neural activation, or even of neural density, in the areas of the brain where the relevant cognitive or emotional processes reside, following a specific type of training or intervention aimed at developing knowledge. Whereas, in the first two approaches described above, the advantage of neuroscience lies in its superior “mapping” of individuals’ strategic decisions, or of the neuropsychological antecedents of those decisions (emotions, cognitions, etc.), here our quest is to evaluate changes in neural responses in the “mapped” areas consequent to learning experiences. By carefully designing their experimental settings (sampling, randomization of allocation of interventions, active and passive control groups, etc.), management researchers can discover how effective alternative learning approaches are in developing specific strategic capabilities.

For example, suppose we were interested in studying competitive strategy interactions in a specific game-theoretic context. We could assess whether the capability to, say, anticipate a longer series of future interactions, as chess players do, is located in regions of the brain that neuroscience literature says should activate when managers exercise these “executive functions” (as neuroscientists call this type of highly evolved cognitive skill). More importantly, management scholars will be able to tackle questions such as: How do managers develop these highly relevant cognitive skills? What are the most effective training approaches for developing them? And, finally, what are the performance implications of these learning processes?

To give another, real-world example, in our study of exploration and exploitation decisions

(Laureiro et al. 2014), the first phase was to “map” these decisions to the underlying neurophysiological correlates in the brains of decision-makers (first students, and then actual managers and entrepreneurs). The selection of the four-armed bandit game, with its simple, repeatable task structure that generates feedback and enables individuals to learn over time, lent itself to studying the performance implications of the capability of switching between the two modes of attention modulation (J. D. Cohen, Aston-Jones, & Gilzenrat, 2004; Daw, O’Doherty, Dayan, Seymour, & Dolan, 2006; Laureiro-Martínez, Brusoni, & Zollo, 2010; Laureiro-Martínez, et al., 2013; Laureiro-Martínez et al., 2014; McClure, Gilzenrat, & Cohen, 2006). However, these same characteristics also allowed us to explore the effectiveness of two very different approaches to the learning problem, one based on neuro-cognitive training (so-called “brain training”) and the other based on meditative and introspective training, in a classical randomized controlled trial design.

In a currently ongoing project, aimed at studying stakeholder strategy in an environmental sustainability context, we approached the research design with a similar two-step approach. The first phase was to identify of the neural correlates for this type of strategic decision, using the “fish-bank” simulation, which poses “tragedy of the commons” problems in an iterative game context. As well as validating the neural “mapping” of these business decisions, we wanted to verify the link between the activation of specific brain regions and the quality of the decisional outcomes, i.e. the sustainability performance generated. The second phase was a randomized controlled trial with the same type of learning interventions, involving both neurocognitive and meditative training, to assess their comparative effectiveness and in a passive control group.

So much for the potential of applying neuroscience to strategic management studies. But what about the converse? What might managerial scholarship contribute to the advancement of

neurosciences? The contributions made by economics and decision-making to cognitive neuroscience are manifest (Clithero, Tankersley, & Huettel, 2008; Huettel, 2010), and there is no obvious reason why equally valuable contributions could not come from our field. For instance, consider the problem of aggregating individual responses up to group or even organizational level. Anthropomorphic metaphors, which attribute traits identified at the individual level to entire organizations, are not particularly helpful. For example, consider the terminology of “hot” and “cold” rationality, or attempts to locate the organization’s metaphorical “left brain.” Neuroscientists are often interested in explaining macro-level phenomena (e.g. why people eat junk food when they know it is bad for their health (Hare, Camerer, & Rangel, 2009)) by observing a few individuals and scaling up to a whole population. Such an aggregation process makes sense for relatively well-structured problems, but works less well in the case of complex organizations, where interdependencies and emergent properties play a crucial role in explaining behavior. Our somewhat contrarian suggestion is that we should not look for similarities across levels of analysis, but rather for *differences* – because it is these that hold the key to the aggregation problem. Below we provide two examples to illustrate our thinking.

First, let us consider attention, a central construct in strategic management research and one of the most studied topics in cognitive neurosciences (Ocasio, 2011). Studies of sustained attention and cognitive control have found that when an individual focuses their attentional resources on a problem, speed and accuracy will be high – and this holds for a range of tasks and for many different samples (Norman & Shallice, 2000; Posner & Petersen, 1990). This is in line with a recent study of a sample of experienced organizational leaders: those with higher attention control were both faster and more accurate (Laureiro-Martínez, et al., 2013). Now, consider an organization that devotes a great deal of attentional resource to solving a particular problem – for example, by organizing a series of meetings involving the top management team, and carefully evaluating the

various options before coming to a decision. The sequential and coordinated attention applied by General Electric (GE) leaders to the issues faced by the firm (Joseph & Ocasio, 2012) is a case in point. This appears to be the opposite of a quick decision process, but why? What changes when we move from the individual to the organization? Clearly, there are issues related to how people interact, and act together, that cannot be explained through a simple head count of the number of individuals involved. For this class of problems, management scholars can provide insights to their neuroscience colleagues. For example, based on Joseph and Ocasio's (2012) findings for GE leaders, one could design an fMRI task that requires individuals to focus their attention sequentially and in a coordinated manner, with the aim of predicting performance in the deliberative and iterative types of decision process observed at GE.

Second, recent work by Francesca Gino and colleagues (Gino & Ariely, 2012) argues that creative individuals seem more likely to exhibit unethical behavior. Creative people think "broadly" and "outside the box," even when considering unethical options. This is an interesting result at the individual level – so what are the implications for organizations that engage in continuous efforts to foster their members' creativity? While individual-level cheating might be tolerated, organization-level cheating is not an option. What structures and processes can be deployed to reconcile seemingly conflicting individual- and organizational-level aims?

In conclusion, we hope this paper advances the discussion on how strategic management research can potentially benefit from the techniques and findings of cognitive neuroscience, and the practical opportunities and challenges that researchers will face when they collaborate across the two fields. In our view, future "boundary-spanners" would do well not to rely solely on the argument that strategy needs neuroscience because it deals with important decisions taken by key individuals. Furthermore, we hope these researchers will have a genuine interest in the theories,

findings, and methods of neuroscience, and recognize their importance in developing a comprehensive pool of research methods for studying individuals. Each method will have its own strengths and weaknesses, its strong complementarities and its useful redundancies. We are convinced that by being clear on these complementarities, and respecting the methodological and ethical boundaries discussed above, we can make real scientific progress that will benefit not only our respective domains, but society as a whole.

## References

- Abutalebi, J., Cappa, S. F., & Perani, D. (2001). The bilingual brain as revealed by functional neuroimaging. *Bilingualism: Language and cognition*, 4, 179-190.
- Ansoff, H. I. (1980). Strategic issue management. *Strategic Management Journal*, 1(2), 131-148.
- Ansoff, H. I. (1987). The emerging paradigm of strategic behavior. *Strategic Management Journal*, 8(6), 501-515.
- Becker, W. J., Cropanzano, R., & Sanfey, A. G. (2011). Organizational neuroscience: Taking organizational theory inside the neural black box. *Journal of Management*, 37(4), 933-961.
- Brown, S. M., & Hariri, A. R. (2006). Neuroimaging studies of serotonin gene polymorphisms: exploring the interplay of genes, brain, and behavior. *Cogn Affect Behav Neurosci*, 6(1), 44-52.
- Cabeza, R. (2002). Hemispheric asymmetry reduction in older adults: the HAROLD model. *Psychology and aging*, 17(1), 85.
- Clithero, J. A., Tankersley, D., & Huettel, S. A. (2008). Foundations of neuroeconomics: from philosophy to practice. *PLoS biology*, 6(11), e298.
- Cohen, J. D., Aston-Jones, G., & Gilzenrat, M. S. (2004). A Systems-Level Perspective on Attention and Cognitive Control. Guided Activation, Adaptive Gating, Conflict Monitoring, and Exploitation versus Exploration. Chapter 6. In M. I. Posner (Ed.), *Cognitive Neuroscience of Attention* (pp. 71-90). New York: Guilford Publications.
- Cohen, M. D. (2007). Perspective--Administrative Behavior: Laying the Foundations for Cyert and March. *ORGANIZATION SCIENCE*, 18(3), 503-506.
- Cyert, R. M., & March, J. G. (1963). *A Behavioral Theory of the Firm*. Englewood Cliffs, NJ: Prentice Hall.
- Dale, A. M., & Buckner, R. L. (1997). Selective averaging of rapidly presented individual trials using fMRI. *Human brain mapping*, 5(5), 329-340.
- Daw, N. D., O'Doherty, J. P., Dayan, P., Seymour, B., & Dolan, R. J. (2006). Cortical substrates for exploratory decisions in humans. *Nature* 441(15), 876-879. doi: doi:10.1038/nature04766
- Eisenhardt, K. M., & Graebner, M. E. (2007). Theory building from cases: opportunities and challenges. *Academy of Management Journal*, 50(1), 25-32.
- Foss, N. J., Heimeriks, K. H., Winter, S. G., & Zollo, M. (2012). A Hegelian Dialogue on the Micro-Foundations of Organizational Routines and Capabilities. *European Management Review*, 9, 173-197.
- Garibotto, V., Borroni, B., Kalbe, E., Herholz, K., Salmon, E., Holtoff, V., . . . Perani, D. (2008). Education and occupation as proxies for reserve in aMCI converters and AD FDG-PET evidence. *Neurology*, 71(17), 1342-1349. doi: 10.1212/01.wnl.0000327670.62378.c0
- Gavetti, G., Levinthal, D. A., & Ocasio, W. (2007). Neo-Carnegie: The School's Past, Present, and Reconstructing for the Future. *Organization Science*, 18(3), 523-536.
- Gavetti, G., & Rivkin, J. W. (2007). On the Origin of Strategy: Action and Cognition over Time. *ORGANIZATION SCIENCE*, 18(3 May 1, 2007), 420-439.
- Gino, F., & Ariely, D. (2012). The dark side of creativity: original thinkers can be more dishonest. *Journal of Personality and Social Psychology*, 102(3), 445.

- Hare, T. A., Camerer, C. F., & Rangel, A. (2009). Self-control in decision-making involves modulation of the vmPFC valuation system. *Science*, 324(5927), 646-648.
- Healey, M. P., & Hodgkinson, G. P. (2014). Rethinking the philosophical and theoretical foundations of organizational neuroscience: A critical realist alternative. *Human Relations*, 0018726714530014.
- Huettel, S. A. (2010). Ten challenges for decision neuroscience. *Frontiers in neuroscience*, 4.
- Huettel, S. A., & McCarthy, G. (2000). Evidence for a refractory period in the hemodynamic response to visual stimuli as measured by MRI. *Neuroimage*, 11(5), 547-553.
- Huettel, S. A., Song, A. W., & McCarthy, G. (2004). *Functional magnetic resonance imaging* (Vol. 1): Sinauer Associates Sunderland, MA.
- Huettel, S. A., Stowe, C. J., Gordon, E. M., Warner, B. T., & Platt, M. L. (2006). Neural signatures of economic preferences for risk and ambiguity. *Neuron*, 49(5), 765-775.
- Joseph, J., & Ocasio, W. (2012). Architecture, attention, and adaptation in the multibusiness firm: General electric from 1951 to 2001. *Strategic Management Journal*, 33(6), 633-660.
- King-Casas, B., Tomlin, D., Anen, C., Camerer, C. F., Quartz, S. R., & Montague, P. R. (2005). Getting to know you: reputation and trust in a two-person economic exchange. *Science*, 308(5718), 78-83.
- Korn, C., Sharot, T., Walter, H., Heekeren, H., & Dolan, R. (2014). Depression is related to an absence of optimistically biased belief updating about future life events. *Psychological medicine*, 44(03), 579-592.
- Laureiro-Martínez, D., Brusoni, S., & Zollo, M. (2010). The Neuroscientific Foundations of the Exploration--Exploitation Dilemma. [doi: DOI: 10.1037/a0018495]. *Journal of Neuroscience, Psychology, and Economics*, 3(2), 95-115.
- Laureiro-Martínez, D., Canessa, N., Brusoni, S., Zollo, M., Hare, T., Alemanno, F., & Cappa, S. F. (2013). Frontopolar cortex and decision-making efficiency: comparing brain activity of experts with different professional background during an exploration-exploitation task. *Frontiers in human neuroscience*, 7.
- Laureiro Martínez, D., Brusoni, S., Canessa, N., & Zollo, M. 2014. Understanding the exploration-exploitation dilemma: An fMRI study of attention control and decision-making performance. *Strategic Management Journal*.
- Laureiro - Martínez, D., Canessa, N., Brusoni, S., Zollo, M., Hare, T., Alemanno, F., & Cappa, S. F. (2014). Frontopolar cortex and decision-making efficiency: comparing brain activity of experts with different professional background during an exploration - exploitation task. 7(927), 1-10. doi: doi:10.3389/fnhum.2013.00927
- Levinthal, D. A. (2011). A behavioral approach to strategy—what's the alternative? *Strategic Management Journal*, 32(13), 1517-1523. doi: 10.1002/smj.963
- Loasby, B. J. (1976). *Choice, complexity, and ignorance: an enquiry into economic theory and the practice of decision-making*: CUP Archive.
- McClure, S. M., Gilzenrat, M. S., & Cohen, J. D. (2006). An exploration–exploitation model based on norepinephrine and dopamine activity. In Y. Weiss, B. Sholkopf & J. Platt (Eds.), *Advances in neural information processing systems* (Vol. 18, pp. 867–874). Cambridge, MA: MIT Press.
- Norman, D. A., & Shallice, T. (2000). Attention to Action: Willed and Automatic Control of Behavior. In M. S. Gazzaniga (Ed.), *Cognitive Neuroscience: A Reader* (pp. 376-390): Wiley Backwell.
- Ocasio, W. (2011). Attention to Attention. *Organization Science*, 22(5), 1286-1296. doi: 10.1287/orsc.1100.0602

- Posner, M. I., & Petersen, S. E. (1990). The attention system of the human brain. *Annual Review of Neuroscience*, 13, 25-42.
- Powell, T. C. (2011). Neurostrategy. *Strategic Management Journal*, 32(13), 1484-1499. doi: 10.1002/smj.969
- Racine, E., Bar-Ilan, O., & Illes, J. (2005). fMRI in the public eye. *Nature Reviews Neuroscience*, 6(2), 159-164.
- Rossini, P. M., Rossi, S., Babiloni, C., & Polich, J. (2007). Clinical neurophysiology of aging brain: from normal aging to neurodegeneration. *Prog Neurobiol*, 83(6), 375-400. doi: S0301-0082(07)00145-1 [pii] 10.1016/j.pneurobio.2007.07.010
- Schlagenhauf, F., Huys, Q. J., Deserno, L., Rapp, M. A., Beck, A., Heinze, H.-J., . . . Heinz, A. (2014). Striatal dysfunction during reversal learning in unmedicated schizophrenia patients. *Neuroimage*, 89, 171-180.
- Schulte-Ruther, M., Markowitsch, H. J., Shah, N. J., Fink, G. R., & Piefke, M. (2008). Gender differences in brain networks supporting empathy. *Neuroimage*, 42(1), 393-403. doi: 1053-8119(08)00488-6 [pii] 10.1016/j.neuroimage.2008.04.180
- Sommer, I. E., Aleman, A., Bouma, A., & Kahn, R. S. (2004). Do women really have more bilateral language representation than men? A meta-analysis of functional imaging studies. *Brain*, 127(Pt 8), 1845-1852. doi: 10.1093/brain/awh207awh207 [pii]
- Venkatraman, V., Clithero, J. A., Fitzsimons, G. J., & Huettel, S. (2012). New scanner data for brand marketers: how neuroscience can help better understand differences in brand preferences. *Journal of consumer psychology*, 22, 143-153.
- Venkatraman, V., Huettel, S. A., Chuah, L. Y., Payne, J. W., & Chee, M. W. (2011). Sleep deprivation biases the neural mechanisms underlying economic preferences. *The Journal of Neuroscience*, 31(10), 3712-3718.
- Venkatraman, V., Payne, J. W., Bettman, J. R., Luce, M. F., & Huettel, S. A. (2009). Separate neural mechanisms underlie choices and strategic preferences in risky decision making. *Neuron*, 62(4), 593-602.
- Venkatraman, V., Rosati, A. G., Taren, A. A., & Huettel, S. A. (2009). Resolving response, decision, and strategic control: evidence for a functional topography in dorsomedial prefrontal cortex. *The Journal of Neuroscience*, 29(42), 13158-13164.
- Winter, S. G. (2013). Habit, deliberation, and action: Strengthening the microfoundations of routines and capabilities. *The Academy of Management Perspectives*, 27(2), 120-137.
- Yarkoni, T., & Braver, T. S. (2010). Cognitive neuroscience approaches to individual differences in working memory and executive control: Conceptual and methodological issues. *Handbook of Individual Differences in Cognition*, 87-107.
- Yin, R. K. (2010). *Qualitative research from start to finish*: Guilford Press.