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Review

Identity economics and the brain: uncovering the mechanisms of social conflict

Scott A. Huettel[1,3,*] and Rachel E. Kranton[2,3]

[1]*Department of Psychology and Neuroscience,* [2]*Department of Economics,*
[3]*Center for Interdisciplinary Decision Science, Duke University, Durham, NC 27708, USA*

Social contexts can have dramatic effects on decisions. When individuals recognize each other as coming from the same social group, they can coordinate their actions towards a common goal. Conversely, information about group differences can lead to conflicts both economic and physical. Understanding how social information shapes decision processes is now a core goal both of behavioural economics and neuroeconomics. Here, we describe the foundations for research that combines the theoretical framework from identity economics with the experimental methods of neuroscience. Research at this intersection would fill important gaps in the literature not addressed by current approaches in either of these disciplines, nor within social neuroscience, psychology or other fields. We set forth a simple taxonomy of social contexts based on the information content they provide. And, we highlight the key questions that would be addressed by a new 'identity neuroeconomics'. Such research could serve as an important and novel link between the social and natural sciences.

Keywords: identity; neuroeconomics; brain; decision; social; interaction

1. INTRODUCTION

Economics studies the allocation of scarce resources. Traditional theories portray the allocation of these resources as a peaceful process: self-interested and competitive people interact through markets, firms or public institutions that govern economic transactions and redistribution [1,2]. Conflicts of interest are solved through contracts, voluntary trade and government policy. These theories privilege people's pecuniary motivations—the desire to consume goods and services—and people act strategically to maximize their own rewards. Pecuniary motivations, or preferences, are largely seen as idiosyncratic, static and context-free [3]. A major effort of experimental and behavioural economics is to see how these motivations operate through experiments. Typical topics for research include the evaluation of risk and uncertainty and the limitations on economic reasoning associated with cognitive biases and bounded rationality [4]. Similarly, recent work using the tools of neuroscience has provided often-counterintuitive insights into the complex, emotional and strategic trade-offs within decision-making [5,6], while still largely treating individuals as independent agents who are motivated primarily by their personal economic outcomes.

Yet, the conception of individuals as selfish and asocial, motivated only by personal gain, fails to account for much widely observed economic behaviour. Individuals do not ignore others; they are alternatively altruistic and fair, envious and status-seeking. Social contexts, far from being irrelevant, tend to dominate many aspects of our economic lives: how others' income affects our own subjective well-being [7], whether we support public goods [8] and why financial work incentives often fail [9].

Understanding how individuals make decisions in social contexts will be paramount for understanding non-peaceful allocation of resources and the associated conflict. Much of the competition for resources takes place outside of markets and firms; obvious historical examples are wars, military conquests and today's battles in developing economies. But even in modern democracies, ethnic and group divisions are salient in setting policy and affect the provision of public goods [10]. While we can easily see the patterns of social divisions and consequences of social conflict on the macro level, the individual actors and their motivations are harder to see. Yet it is individuals who are being fair to some people and not fair to others. And it is individuals who are acting to advance their group's interests, often at personal cost.

An emerging framework in the social sciences—'identity economics'—considers people in the context of their larger social groups and the motivations those groups engender. Identity economics aims for a foundational understanding of social motivations and how these motivations depend on social identities and social context [9,11]. It seeks to identify non-pecuniary sources of human motivation and the

* Author for correspondence (scott.huettel@duke.edu).

relation between these motivations and social context. On the one hand, people with social motivations will take personally costly actions to advance social goals. Conversely, behavioural experiments show undesired behaviours can become *more* prevalent when explicit monetary incentives are introduced [12]. These effects occur, it is hypothesized, because the pecuniary incentives (e.g. goods and money) crowd out the social incentives (e.g. strength of a social relationship) as the primary motivator of behaviour [13]. By considering the motivational properties of social contexts, economists not only address a broader space of human decision-making (e.g. including choices between sets of social consequences), but also gain traction on the complex interactions and trade-offs between pecuniary and social consequences. This framework shares intellectual origins with other approaches for addressing actual or perceived limitations of traditional rational choice models. As one notable example, examination of choice behaviour within real markets and laboratory experiments led Vernon Smith to propose the idea of a 'ecological rationality': individuals exist in a milieu of social ties and constraints, and they attempt to optimize their behaviour to fit that environment, not the prescriptions of an abstract model [14].

Identity economics, though a promising contributor to models of group interactions, has notable limitations. Like other frameworks in economics, it does not consider questions of individual differences or of mechanism: why do some individuals show strong other-regarding preferences, while others do not? How do our identities—and their effects on our thoughts and actions—change over the course of our lives? How are social and financial incentives integrated in complex decision-making? Hereafter, we argue that answers to these and similar questions will require an integration of new economic models of identity with new research from neuroscience on the mechanisms of social decision-making. Such an integration would not only provide new insights into the causes and consequences of social conflict, but would also open up important new directions of research in each of these fields. Moreover, it could provide a bridge to research in mechanism design and institutional economics, which now considers how social structures (e.g. legal systems and cultural norms) shape how economic institutions and societies develop [15].

2. ADDING IDENTITY TO ECONOMICS

Identity economics focuses, at its core, on individuals who make decisions in a social context [9,11]. The framework of identity economics follows economists' method of positing a 'utility function' to represent individual motivation. In principle, a utility function can express any sort of motivation. Traditional economic analysis concentrates on pecuniary motivations, such as desire for consumption and income to procure goods and services. Identity economics brings identity and social context into a utility function, inspired by the social psychology on social conflict and identity.

Identity economics is a recent advance that brings models of economic behaviour closer to the behaviour of human beings. In the classic model, people have individual, idiosyncratic tastes for these goods and services. This is the stick figure, 'Homo Economicus', of a rational and optimizing human being that populates most economic models. In the past 20 years, utility functions have been developed to express a wide array of non-pecuniary tastes and preferences, such as the desire for children, the concern for status and the desire for fairness and retribution [16,17]. Yet, with rare exceptions, the basic presumption has remained that such tastes and preferences are individual and idiosyncratic characteristics, independent of social context and social groups. Altruism and fairness are generic; some people more altruistic or fair, others less. This presumption ignores that these social preferences depend in large part on people's identities and social norms for behaviour in different social contexts.

Identity economics incorporates social identity and norms into economic theory, and the observed relation between social preferences and identity also drives our proposed research agenda in identity neuroeconomics. Take the examples of 'fairness' and 'inequity aversion'. Leading economists, including John Nash, Hal Varian, Matthew Rabin and Ernst Fehr have brought these social motivations into economics' purview. They propose utility functions with preferences for fairness that explain many behavioural experimental results where subjects make choices that look fair and equitable, rather than simply maximize their individual payoffs. Any variation in experimental choices is treated as noise or at best individual variation in preferences.

But outside university laboratories, in the real world, conceptions of fairness depend on the social context and identities. In many social contexts, it is seen as normal to treat certain other people unfairly and even cruelly. This observation is as important as it is obvious. In Rwanda, ethnic groups did not treat each other equally. In America, whites did not treat blacks equally. In many societies today, men do not treat women equally. People's preferences for fairness depend on who is interacting with whom and in what social setting.

Along these lines, experiments whose designs consider social context and match people with different social identities yield quite different outcomes. Experiments in social psychology, and now increasingly in economics, show that social divisions affect individual choices. The seminal Robbers' Cave experiment in 1954 separated 11 year old boys into two groups for a week at a state park. When the boys were brought together in the second week to play competitive games, the experimenters describe the 11 year old equivalent of war with name-calling, raiding huts and burning flags [18]. This phenomenon—that *a priori* social divisions lead to strong affiliation with group identity and (often) social conflict—has been replicated across a wide range of settings in both natural and laboratory settings [19].

Subsequent experiments aimed to find minimal conditions that would create consequential social divisions. In these 'minimal-group' experiments, subjects are divided into groups according to stated preferences on paintings or by simple assignments as even and odd. The first experiments by Tajfel and

co-workers [20] asked subjects to choose from a list assigning points to a member of their own group and to a member of the other group. The main finding is that subjects were more likely to pick the pairs of points that maximized the relative difference in points, rather than the pair which maximized the absolute number of own points or total points. Recently, economists have adopted this paradigm and shown that social divisions created in the laboratory matter even when there are monetary stakes [21]. And a growing number of economic experiments using classic games—like the 'trust game', 'ultimatum game' and 'public goods game'—find effects of real-world social divisions. Subjects exhibit in-group preferences. They give more to in-group members in allocation games and return more to in-group members in trust games [22,23]. These experiments differ from traditional social psychology experiments in that real monetary stakes are involved. They also differ from traditional economic experiments in that experimental design manipulates the social context.

All these experiments give support for the basic premises of identity neuroeconomics. Social identity and social context are central variables in decision-making and economic interactions. And utility functions with social motivations, such as fairness or inequity aversion, should explicitly incorporate social identity and social context.

(a) *Utility as a function of identity*

We adopt Akerlof & Kranton's [9] utility function to formalize these variables. It provides a framework to see how behaviour changes when identity and social context are salient. A standard utility function would represent the utility of person j as

$$W_j(a_j, a_{-j}), \tag{2.1}$$

where a_j denotes j's actions and a_{-j} denotes others' actions. Examples of such actions could include prices that people set, effort that people exert at work or choices over allocations of incomes. In a basic interpretation, a person's utility then depends on his own consumption of goods and services, procured though his actions and on others' consumption of goods and services. Particular forms of the function $W_j(a_j, a_{-j})$ would capture the standard economics of own consumption and externalities, as well as strategic interaction. Special forms of equation (2.1) also can capture social preferences such as altruism, fairness or inequity aversion, because utility depends on both a_j and a_{-j}. What is missing, thus far, however, is how the utility depends on the particular identities of j and $-j$ and the social context.

Akerlof & Kranton [9] propose three elements to capture identity and social context. First, *social categories*, denoted C, give the potential divisions in the population. Individual j assigns self and others to these categories, and we denote this assignment c_j. Following common usage, j's assignment is called individual j's 'identity'. Second, *norms and ideals*, denoted by N, describe appropriate behaviour and ideal attributes of each social category. And, *identity utility* captures the gains and losses by adhering to or

deviating from the norms N. Akerlof & Kranton [9] posit the following function for identity utility:

$$I_j(a_j, a_{-j}; c_j, \varepsilon_j, N). \tag{2.2}$$

Identity utility depends on the extent to which own and others' actions match prescribed behaviour, given by N. The utility also depends on the status of j's social category, and the match between j's own attributes, denoted ε_j and the ideal of their social category (also given by N). Overall, the new utility function is

$$U_j(a_j, a_{-j}, I_j), \tag{2.3}$$

where, as before, a_j denotes j's actions and a_{-j} denotes others' actions.

In the simplest case, what economists call the 'short run', individual j chooses actions a_j to maximize utility U_j, taking as given c_j, ε_j and N, and the actions of others. In a more complex setting, what we might call the long run, to some extent j may also 'choose' the variables that are fixed in the short run. Individual j could choose category assignment c_j. Categories may be more or less ascriptive, and in a society with fluid social boundaries, people may have some choice as to who they want to be. Individual j's actions may also affect the norms, N, the set of social categories, C, as well as the status of different categories reflected in $I_j()$.

This utility function represents social and identity preferences, and this model has been used to explore the consequences for different realms of economics. Models of the above form have been applied to problems of supervisory structures in firms, conflict between groups in school settings, and irregularities in labour markets [11].

While a utility function represents motivations, it does not explain them or how they work. This utility function does not include, for example, why people have strong group affiliations and why these affiliations are salient at some moments and not others. It does not explain the different behaviour of individuals and subgroups (e.g. why younger people have stronger group affiliations and are more subject to group influence than older people). The utility function posits a trade-off between pecuniary rewards and non-pecuniary rewards, but it does not provide the foundations of that trade-off.

The neurobiology of decision-making will allow us to elaborate the effects of identity preferences on behaviour. For a better understanding of social preferences and social conflict, we must build a theory that incorporates the elements of identity (i.e. category concepts, norms and ideals) and describes the processes by which those elements guide decisions. In §3, we describe recent work in neuroscience that has begun to link social cognition and decision-making.

3. MECHANISMS OF DECISION-MAKING IN SOCIAL CONTEXTS

Research in neuroscience, nearly all conducted during the past decade, has identified potential biological mechanisms for how social identity might enter into decision-making. Given the relevance of social information to many real-world decisions, one might

expect that these two topics would be highly inter-related; that is, studies of decisions in social contexts would be common. Yet research in these two areas has largely proceeded apace. Below, we briefly summarize what is known about the underlying brain mechanisms, while emphasizing the important points of contact that are yet to be made.

(a) *The neural basis of valuation and decision-making*

Neuroscience studies of decision-making (often called 'decision neuroscience' or 'neuroeconomics') have focused largely on simple decisions about economic rewards [5,6]. In a typical paradigm, a volunteer participant views two options—say, a smaller amount of money available now or a larger amount of money available later—and then chooses between them. Most experiments follow the conventions of behavioural economics [24] and use incentive-compatible designs with real monetary payoffs for a subset of the decisions. While the participant makes a series of such choices, data are collected using functional magnetic resonance imaging, electroencephalography or another technique. The researchers then examine how differences in the nature of the decision (e.g. difficult versus easy comparisons), the choice that is made (e.g. choosing a safer or riskier option) or the individual's economic preferences (e.g. whether they are relatively loss-averse) modulate the neuroscience data. Of note, both human and animal studies are common, and in many cases they have used similar research paradigms and reached converging conclusions.

Broadly considered, goal-directed decision-making relies on processes related to valuation of potential rewards, integration and comparison of different outcomes in a complex decision, and learning from past outcomes to guide future decisions [6]. The first class of processes, valuation, has by far the best-understood neural mechanisms. Activity of dopaminergic neurons within the brainstem tracks incoming information about potential rewards. Importantly, these neurons do not merely respond to rewards themselves. Instead, their activity carries a signal for 'reward prediction error'; i.e. whether a reward or information about future rewards was better or worse than expected [25]. These neurons, along with other less well understood counterparts that may be specific for aversive stimuli [26,27], send their signals broadly throughout the brain, including particularly important projections to the orbitofrontal cortex and to the ventral striatum [28]. The orbitofrontal cortex plays an important role in the second class of processes, integrating information about different choice options, to determine the utility or 'willingness to pay', for a particular outcome [29]. For many decisions, one has to integrate not only the value of rewards, but also their risk, ambiguity, temporal delay and personal relevance; information about these properties appears to be computed within regions of lateral prefrontal cortex and parietal cortex [30–32], before feeding into the orbitofrontal cortex. Finally, the brain monitors the outcomes of our prior choices to update both our expectations about rewards and our future strategies

for decision-making. Regions of the dorsomedial prefrontal cortex [33,34] and the striatum [35] track the effectiveness of previous decisions and bias future decisions through their projections to the reward system, lateral prefrontal cortex and parietal cortex.

(b) *The neural basis of social cognition*

Understanding the basis of social cognition has also been a major area of emphasis in modern neuroscience [36]. The associated research (often called 'social neuroscience') has followed a different set of methodological principles and has targeted very different brain systems. No prototypical paradigm exists in social neuroscience. Some studies involve perception of stimuli that carry information about other individuals [37], others involve evaluation of the social consequences of actions [38] and still others involve active interaction with other individuals [39,40]. Real-world social interactions are difficult to replicate within the restrictive environment of a neuroscience laboratory (e.g. while a participant is lying within the confines of a magnetic resonance imaging (MRI) scanner), and so researchers have developed a number of computerized paradigms that abstract core elements of social cognition [40]. A substantial majority of research involves human participants, typically young, college-educated adults, although there is also considerable work in aspects of social processing (e.g. face perception, social dominance) within non-human primates [41]. Finally, the conceptual frameworks for this research are often drawn from social psychology, which gives it a rich theoretical grounding, albeit with less of a computational emphasis than decision neuroscience [42].

Social cognition comprises a diverse set of processes that allow individuals to recognize other agents in the environment, to infer those agents' intentions and goals, to place themselves in a social context and to infer social relationships among individuals and groups [36,43,44]. Of these, the neural underpinnings of social perception are best-understood. Broadly summarized, social perception relies on a distributed network with several elements [36,45,46]: regions in the ventral visual stream (e.g. identifying faces via the fusiform gyrus), the lateral parietal cortex (e.g. recognizing intentions via the temporal–parietal junction, TPJ) and the amygdala (e.g. evaluating emotion).

Yet, even these seemingly straightforward links between social cognition and brain function have been controversial. For example, damage to the lateral parietal cortex usually leads to deficits in selective attention but not an inability to perceive social stimuli [47]. Identifying higher level processes that are specific to *social* cognition has been similarly challenging. One compelling possibility comes from research on self-referential processing, which has identified the anterior part of medial frontal cortex as a key contributor [48]. Activation in this region increases during consideration of one's own characteristics, compared with another's; however, the magnitude of its response to another individual depends on how similar they seem to oneself [49]. Conversely, when someone perceives or interacts with an individual who comes from a very dissimilar

social group (e.g. drug abusers and homeless), this and other regions show diminished activation, consistent with models of dehumanization [50].

Considered collectively, social neuroscience research remains in a very early stage. Some brain regions seem to be selective for social information (e.g. fusiform cortex), others seem to support general processes that are frequently engaged in social settings (e.g. amygdala), and for still others the relative social specificity remains an important area of current research (TPJ). Even so, there is sufficient consensus that at least some neural mechanisms are selective for social cognition, which in turn provides potential targets for research linking social and decision processes.

(c) How does social information modulate decision mechanisms?

Information about the social context—what we call 'social information'—can shape decisions in (at least) three distinct ways: individuals may treat information differently when it comes in a social context, individuals may derive utility from others' outcomes (either positively or negatively), and individuals may derive utility from how they treat others in particular social relationships (e.g. fairness). These three ways correspond, in rough senses, to three routes for interactions between social cognition and decision-making mechanisms within the brain.

First, social information may engage cognitive resources for attention and executive function that change the inputs to decision-making systems. One way this can occur was alluded to in §3b: Social information may preferentially engage regions of the lateral parietal cortex that support attention to relevant stimuli, thus encouraging sustained processing of that information. For example, when individuals viewed another agent taking an action to earn a reward for a charity, the magnitude of their lateral parietal cortex activation was correlated with an independent measure of self-reported altruism [51]. Control systems in the prefrontal cortex may even have separate processing pathways for social and non-social information. In a striking result [52], separate regions within dorsomedial prefrontal cortex track changes in reward expectations depending on whether the information comes from a social source (i.e. another person versus a computer).

Second, social information about others' state may itself be valued, and thus influence the brain's reward system [53]. Neurons within several reward-related regions exhibit changes in their firing rate when monkeys view socially relevant images; as examples, the firing rate of parietal cortex neurons increases when viewing photographs of oestrus displays or of high-dominance monkeys, but decrease when viewing low-dominance monkeys [54]. Analogous phenomena have been identified using neuroimaging studies in humans. Activation in the ventral striatum and orbitofrontal cortex is observed when individuals view photographs of attractive individuals [55], and activation in the latter region also tracks how much people are willing to pay to view such attractive photographs [56]. Rewards given to others (e.g. preferred

charities) also activate these brain regions [57], with the magnitude of the response proportional to the relative value between social and personal reward [58]. Not all social information is positively valued, however. When individuals view another individual being mistreated, activation is observed both in regions associated with social cognition and in the insular cortex [59], a region associated with aversive stimuli such as pain, risk and monetary loss. But, when an individual takes action to rectify the mistreatment—such as when punishing the offender—there is increased activation in reward-related regions such as the ventral striatum [60]. These examples share the common theme that social information can be a powerful modulator of reward processing within the brain.

Third, new information may change the perceived social relationship between oneself and another person, thus shaping how one approaches future interactions. A simple example can be seen in the development of cooperation. In the canonical Prisoner's Dilemma game, repeated play between two partners typically leads either to continual cooperation (with maximal payout for the dyad) or to continual defection (with minimal payout). An early neuroimaging study of this game demonstrated that signals of ongoing cooperation led to increased activation in reward regions [38], a result also found in a subsequent study of the intention to trust in an investment game [39]. Conversely, overtly competitive actions—such as making a low offer in the ultimatum game—instead lead to increased insular activation [61]. More complex examples come from situations in which a particular sort of social relationship is itself of value. For example, the common phenomenon of inequality aversion reflects the typical preference for fair distributions of resources across individuals. Actions that increase the fairness of resource distribution, compared with an equally rewarding outcome (for oneself) that does not reduce inequity, lead to greater activation in the reward system [62,63]. And, individual differences in the willingness to accept actions that increase unfairness have been related to relative activation in the lateral prefrontal cortex, a region important for self control [64,65].

While each of these three routes has been the subject of considerable study, each has only made tentative first steps towards potential influences of group status or identity. Nearly all studies of interpersonal interactions, so far, have used abstract social relationships (e.g. 'opponents' or 'partners' in games). A core goal for future research, accordingly, will be to incorporate meaningful real-world relationships into experimental paradigms. In the following sections, we consider how real social relationships—as determined by one's own and others' identities—have been incorporated into economic modelling, which in turn suggests the next steps towards a neuroscience of social interaction.

4. WHAT WOULD AN 'IDENTITY NEUROECONOMICS' COMPRISE?

To appreciate the challenge of incorporating identity into neuroscience, consider the relatively sterility of the typical neuroeconomic experiment. In most
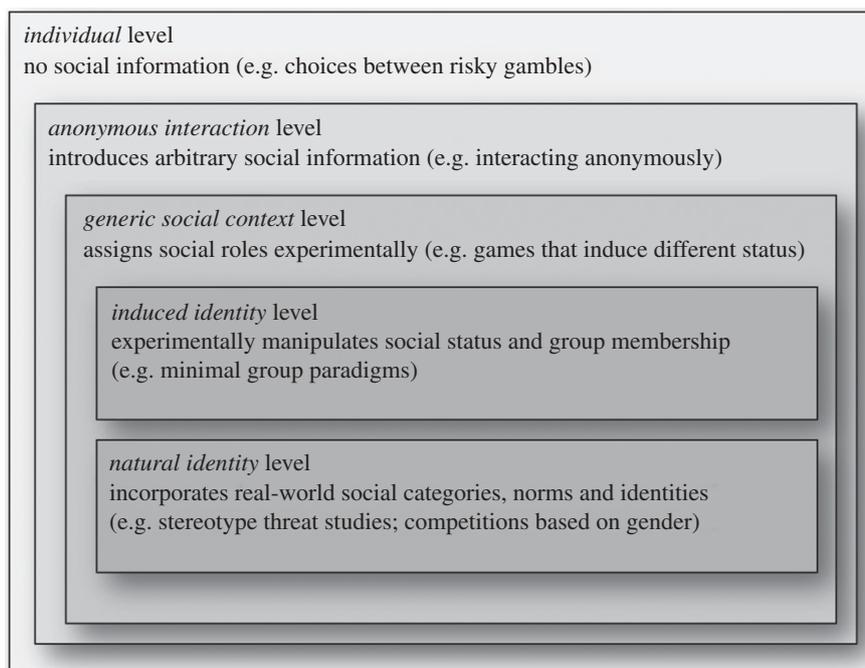
Figure 1. A taxonomy for social contexts in experimental design. Four distinct levels of social context are present within experiments in the social and neural sciences. At the simplest level (*individual*), no social information is present to guide behaviour. Successive levels introduce social information in a context-free manner (*anonymous interaction*) and then a social context that differentiates individuals within the experiment (*generic social context*). The highest level experiments introduce meaningful social categories, either through experimental manipulations (*induced identity*) or through an incorporation of real-world information about individuals' identities and the accompanying social norms (*natural identity*). Research at this highest level will be critical for modelling social cooperation and conflict.

current studies, individual participants come into the laboratory, meet an instructor who explains the experiment, then lie on a MRI scanner and are whisked into the centre of a cramped, noisy tunnel, where they make a series of decisions to earn themselves money. Even in the uncommon cases where a participant interacts with another individual, as in examples within the previous sections, that information is devoid of *social context*. Hereafter, we describe a conceptual model for introducing social context into neuroscience research, along with the methodological changes that such introductions would require.

(a) A taxonomy of social context

The identity economics framework allows organization of experiments in terms of the social setting they comprise. Four distinct levels can be defined (figure 1). In the first two levels, subjects engage in experiments that are largely devoid of social context. These levels correspond to the traditional economics of self-interested, anonymous individuals. In the remaining two levels, experimental subjects are asked to perform tasks within a social context and this context becomes part of the experimental design. Each successive level brings more specificity and realism to the context in terms of social identity and group affiliations.

First, the *individual* level involves research where a single individual takes actions that only have personal consequences. In terms of the utility function (2.3), an individual j is asked to make decisions about a_j that only affect his own utility; there is no a_{-j} or any

other terms that affect the individual's utility. The vast majority of current work in cognitive psychology, cognitive neuroscience, experimental economics and neuroeconomics—indeed, within the social and natural sciences more generally—falls at this level. Typical examples come from the study of decision-making under risk [31,66]: Young adults (often students at a research university) come to the laboratory as volunteers for a research study, make a series of choices between options with different probabilities and values, and earn money based on the nature of their choices. The information collected about those individuals, if any, tends to involve measures of economic preference (e.g. loss aversion) or personality traits (e.g. impulsivity). And, the research goals are to understand patterns of behaviour or component processes that generalize across a large sample.

Second, the *anonymous interaction* level involves studies where individuals interact with another subject, but this interaction is void of any particular social context. In terms of the utility function (2.3), an individual j is now concerned with both a_j and a_{-j}, but there is no content to the relationship between j and $-j$. Participants in experiments are matched with an opponent or partner, and asked to engage in a task. The interaction is generic in that the opponent or partner is purposefully made anonymous; the experiment strips away any existing social cues and context, and the matched subjects are randomly drawn from the population. This sort of paradigm has become central to social psychology and social neuroscience, but is also prevalent within behavioural economics and

neuroeconomics, and even exists within cognitive research as well. Examples of research at this level in experimental economics include the study of departures from Nash equilibria in strategic interactions such as Prisoners' Dilemma games, beauty contest games and public goods games. Neuroscience experiments at this level gain basic knowledge about how people process information from and about others, as in the cases of face processing, evaluating descriptions of others' thoughts and the biological basis of altruism. Within the particular experiment, however, no social categories exist; e.g. the photograph is of an unfamiliar and anonymous individual with whom there have been previous interactions and no interactions are possible. While participants might project a social context onto the experimental stimuli, such as when people perceive faces or even complex interpersonal interactions from the arrangement of simple geometric shapes [67], at this level there is no experimental manipulation of those social categories.

Experiments in the third level, *generic social context*, create relationships between participants in the laboratory, but these relationships do not involve social identities or groups. These experiments study how people behave in generic social situations, such as a social hierarchy. In terms of utility function (2.3), individual j cares about his own and actions and others' actions (a_j, a_{-j}) and there is a category assignment, c_j, which tells subject j his role and others' roles in the experiment. The experimenter places subjects into particular positions within a game, such as 'sender' and 'receiver', or assigns them roles, such as 'supervisor' and 'worker'. These positions confer to subjects different payoffs as part of the game structure. The roles themselves also have social content, as a supervisor could be understood to be in a superior position than a worker. Like its predecessor, this level is common within both social psychology and behavioural economics, as well as within their neural counterparts. Studies at this level can involve trust games [68], the effect of social status on prices [69] or descriptions of other individuals' ethical traits [70], among many features. Here, social information is not only present, but can also guide behaviour. The common 'ultimatum game', for example, involves two players: a proposer who suggests a division of some resource (e.g. splitting $20 into shares of $15 and $5) and a responder who accepts (or not) that division. Each player has a distinct role—and thus social category—that can lead to different perceptions of fair divisions within this game. But, this social content does not confer or exploit social identities of participants and therefore these experiments do not invoke related processes.

The fourth level, the *identity* level, introduces some form of social identity into the experiment. This level can be divided into two types: (i) experimenter-induced identities and (ii) real-world identities.

In *induced identity* experiments, the experiment creates and manipulates both social categories and an associated sense of belonging to a generic group. In terms of equation (2.3), individual j cares about his own and actions and others' actions (a_j, a_{-j}) and subjects are divided into groups, which gives the category assignment, c_j. There are usually no explicit norms for

behaviour or ideal of the category. Such group manipulations have a long history in social psychology [19], often in the form of minimal-group paradigms discussed earlier, which divide individuals based on some arbitrary and explicitly manipulated criterion (e.g. preferences for paintings and coin flips). Importantly, such seemingly innocuous experimental manipulations can have substantial effects: individuals are more willing to allocate money to members of their group, compared with members of another group, even though no systematic connections exist between the group members [21]. Grouping can also be an important tool for coordination. Stratifying individuals based on their actions in the laboratory, such as their ability to contribute within a cooperation game (e.g. merit-based grouping), can lead to salutary outcomes for the group as a whole [71]. We use the label *induced identity* for studies of this sort to emphasize that they can generate robust effects (e.g. in-group favouritism). Yet, the nature of that identity is induced in the laboratory and is ephemeral; group memberships are neither derived from nor extensible to real-world settings.

Natural identity experiments incorporate participants' identities outside the laboratory into the experimental design. Information that defines real-world identity (or category labels themselves) would be available within the experiment. Here individual j cares about his own and actions and others' actions (a_j, a_{-j}) and category assignment, c_j, derive from social identities revealed by the experimenter. For example, the experimenter may tell or show the subjects the last names of their opponents [23], their major field of study [72] or their race [22]. In these experiments, the ideals of the categories and the norms for behaviour derive from real-world norms and ideals, and indeed the experiment is designed to see whether such norms and ideals can be inferred by subject choices. The category assignments, norms and ideals would give identity payoffs I_j from different choices, and thus change subjects' incentives.

Studies involving *natural identity* are relatively rare in economics and are nearly absent from neuroscience. The closest examples involve studies of how specific demographic or cultural variables influence behaviour. Research on stereotype threat [73] has shown that older adults do more poorly on cognitive tests (e.g. show impairments in short-term memory) when primed with cultural norms about ageing (e.g. 'older adults are slower and less vibrant than younger adults') [74]. A major challenge for research at this level comes from the complexity of real-world social categories. Every individual falls into many different categories, each with potentially contradictory norms and ideals. Thus, although the *natural identity* level provides the most ecological validity of any in this taxonomy, it has the least experimental control. In §4*b*, we outline key methods for experiments at this level.

(b) Methods for identity neuroeconomics
While research at each of these levels provides important information about decision-making—and brain function—the final level, involving induced or natural social identities, holds the most promise for

understanding the basis for social conflict. Yet, conducting research of that sort will require fundamental changes to current practices, especially within neuroscience.

One very visible change will be in the methods for assembling the sample of participants. Most cognitive neuroscience experiments consider their participants to be drawn randomly from the population at large; this allows generalization from a relatively small sample to the larger population using random-effects methods [75]. Few samples, however, are truly random. The vast majority of published work—with the exception of studies of clinical disorders—uses samples of convenience, usually young adults drawn from university communities. Such samples will be inappropriate for many questions involving identity, in that a random sample may over represent some social categories (e.g. 'student') and not include others of interest.

To overcome this challenge will require researchers to use a two-stage sampling procedure similar to that used within studies of personality within psychology: an initial screening of a much larger sample will assess each individual on a range of social categories, allowing a sample of the desired size and category properties to be assembled. Because many social categories will be correlated with cognitive or personality factors (e.g. 'good student' may co-occur with intelligence and conscientiousness), the central challenge for researchers will be to develop *a priori* predictions about factors of interest, so that they can control for other variables at the time of sample selection.

Incorporating identity measures would not, in contrast, have dramatic effects on experimental design. As described in §4a, existing paradigms within the social sciences can be modified to include information about identity; e.g. the same interactive game can be played with those who share a salient social category and those who do not.

What identity requires, instead, will be changes in approaches to data analysis. In many cases, social categories will modulate the basic mechanisms described in earlier sections. This will require two sorts of analyses, the first becoming more common but the second still rare. First, research designs will need to look for interactive effects of category relationships upon basic mechanisms. Initial analyses will map out basic functions (e.g. processing of the reward system) and then follow-up analyses will assess how those functions depend on social category (e.g. in-group versus out-group effects). Second, social categories might change the very strategies people use to resolve a decision problem [33], just as they change how people perceive and process their interactions with others. Thus, researchers must analyse how social categories alter the *interactions* between brain regions (e.g. influences of control processes in prefrontal cortex on the reward system), for which functional connectivity analyses will be critical.

Finally, a focus on social categories and identities will lead to new methods for drawing inferences from neuroscience data. As noted previously, most neuroeconomic research seeks to understand the basic mechanisms of decision-making, and uses statistical approaches that generalize inferences from a small sample to the population from which that sample

was drawn. Once social identities are introduced into experiments, researchers will need to separate both specific and general effects. The former would be evident when differences in social category lead to differences in neural mechanism. For example, the degree of affiliation with the category 'older adult' might predict susceptibility to stereotype threat during challenging cognitive tasks [74], and in turn failures of inhibitory control in prefrontal circuits [76]. Other categories—'young adult', 'engineer'— might not lead to such effects. General effects would arise when social identity, itself, becomes relevant to the task at hand. Evaluating whether a partner in an economic game comes from one's own category might require similar processing, regardless of category. These specific and general effects might both occur in the same paradigm. Decisions (and underlying mechanism) within the ultimatum game might be influenced both by whether the opponent comes from the same social category, as well as the relative relationship between the two players' social categories (e.g. if one comes from a higher status group). Inferences drawn from an identity neuroeconomics experiment, therefore, will need to be conditional on properties that generalize across social categories (e.g. whether that category is positive) and aspects of identity that are specific to individual social categories.

5. OPEN QUESTIONS FOR LINKING IDENTITY TO THE BRAIN

Until recently, the idea of a 'neuroeconomics of identity' would seem impossibly vague and impractical. The sceptic would consider the three concepts embedded in that phrase to describe fundamentally different spheres of influence: the brain, market forces and self-concept. The methods for understanding each of those concepts are remarkably diverse. Neuroscientists study brain function by the systematic study of very small samples: a study using human volunteers may involve a few dozen participants, research on the damaged brain may involve a handful of patients and experiments using non-human primates often only involve two or three animals. Research in economics, in contrast, often involves the collection of much more limited data from much larger samples (e.g. thousands of individuals, in national surveys), often with the goal of modelling real-world outcomes. And research on the nature of identity pervades many fields, not only social sciences such as psychology and sociology, but also much of the humanities—with a concomitant diversity of methods from laboratory experiments to introspection. Yet, within this enormous space of potential scholarship, there lie three classes of problems that provide direction for identity neuroeconomics.

(a) *How are identities constructed and applied?*
In any person's life, some social categories are more transient, others more permanent. For example, race, gender and ethnicity only rarely change over the course of a lifetime. Moving from adolescence to adulthood and into retirement are identity transitions that occur infrequently and are often marked by

rites of passage (e.g. baptisms and weddings). Identities associated with political preference or geographical location may change frequently for some people, but never for others. And affiliation with some social groups (e.g. rooting interests in sports teams) may be remarkably transient. The development of identity is a classic topic in anthropology [77], social psychology [78] and sociology [79], but has received little attention within either economics or neuroscience.

Although many different social categories can generate a sense of identity—and can be modelled within the economic framework described earlier—those identities may develop via very different paths. A core challenge for any mechanistic account of identity, therefore, will be to distinguish between the more permanent and more transient sorts of identities. That is, do different sorts of identity arise from fundamentally different mechanisms, with different consequences for decision-making? One intriguing possibility is that the social categories that change least frequently (e.g. race and gender) may serve as organizing frameworks for many aspects of memory (e.g. how one categorizes events in one's life), which makes them very resistant to control processes such as emotion regulation [80]. In contrast, more labile social categories may be shaped by control processes, allowing people to amplify or diminish their importance based on current context. This possibility leads to testable predictions about how different social categories will be associated with different sorts of interactions between prefrontal cortex and brain regions that support emotion.

Moreover, the same person will have multiple identities. For example, a person could think of himself, and be seen by others, as both a father and as a worker. Each of these identities could be more or less salient in different settings (e.g. at home versus in the office), where the norms for each could support each other, or conflict. As the sphere of social relationships is expanded, more identities will be added to the list (e.g. 'coach', 'brother', 'customer'). Thus, any decision can involve conflict not just between monetary rewards and identity, but also between the imperatives of different identities. Neuroscience data will play an important role in understanding trade-offs between different non-pecuniary rewards. In particular, it can provide both information about the relative value of social and non-social rewards [56] and tools for understanding how identity information feeds into processes of valuation [81]. Such data could address important questions about individual variation: what differentiates between people whose identity depends more on social context? And it could also allow extension to important new areas of research: how should changes in biology, such as when an individual progresses from working adulthood to retirement age [82], shape economic models?

(b) How does identity affect resource allocation?

As discussed earlier, traditional economics presents resource allocation as peaceful competition among strategic, anonymous, individuals. The social aspects of interaction are pushed into the background, at a minimum, and often expressly eliminated entirely [83]. Yet, few economic interactions are truly anonymous and free of social context and identity. The shopper in a supermarket is aware of the other shoppers and the brand characteristics of the supermarket chain; the Wall Street trader knows about their competitor traders and their relative position within a firm. The decisions of these individuals—like those in laboratory experiments—may be modulated both by financial and social motives. As described in earlier sections, neuroeconomic research has suggested that social information alters neural systems for decision-making, although the specific nature and scope of such influence remain incompletely understood. Two sorts of questions will be central to new research in identity neuroeconomics.

First, and most generally, what sorts of social information matter for resource allocation? Many factors could contribute to even a simple decision: one's own outcome (self-regarding), the outcome for the social partners in the game (other-regarding), the total outcome for the group (greater good), the relative outcome among members of the group (fairness) and how a distribution compensates for prior distributions (inequity aversion), among others. Each of these factors has been demonstrated to modulate the brain's reward system, suggesting that they may rely in part on common neural mechanisms. Yet, the trade-offs between them may be anything but common. In real-world settings, individuals show considerable heterogeneity in their relative valuation of these factors, which in turn leads to variability in decisions. Embedding decision tasks into social contexts will be critical for construction of models that account for each of these factors.

Second, how do resource allocations depend on the specific social context; i.e. who is interacting with whom? The same pair of individuals might interact very differently depending on the social context (e.g. whether they believe themselves to be part of the same group or rival groups). The introduction of social context can have dramatic effects on the value placed on fairness, particularly when in- and out-group status becomes very salient. We contend, therefore, that no general economic model could account for social interactions without including specific identity relationships among individuals.

(c) How does identity affect the integration of financial and social incentives?

Prices are the basic metric in economics. Economists measure how much people like a good or service by a person's willingness to pay (WTP) for that good or service. For example, economists measure the strength of people's preferences for fairness by how much people are willing to give up in own payoffs in order to achieve a fairer distribution. This approach has been extended to study non-pecuniary and social motivations and is now commonly used in neuro-economic research [6]. But is WTP a valid measure of all social preferences? As the examples from §1 of this paper testify, social and financial incentives are often not directly commensurable.

The utility function described earlier (equation (2.3)) can capture a range of non-monetary outcomes (e.g. the rewards from being fair or the gain from higher status). In some cases, neural measures may provide direct insight into how much a social good is worth, by providing a choice-free measure of its valuation [84]. More likely, however, will be indirect evidence of the processes associated with a particular trade-off. What computations allow comparison of, say, increases in salary (e.g. a rise by moving to a new firm) against reductions in status (e.g. a lower rank within the new firm)? Of the many sorts of possible computations—from regulation of emotional responses to suppression of conflicting information—only some might be evident in particular social contexts. Identifying those computations and how they are engaged in asocial, conflictual and non-conflictual contexts will be central goals of an identity neuroeconomics.

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