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ORIGINAL PAPER

Neural Bases of Sector Bias in Perceptions of Public Versus Private-Sector Service Performance

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Abstract

Governments, political parties and public institutions regularly design and launch communication campaigns emphasising their successes, fostering participation in democratic acts, promoting the use of public services and seeking to boost electoral support. Accordingly, researchers in the fields of politics and public administration have long sought to enhance our understanding of how individuals perceive the performance of services offered by the private and public sectors. In this respect, conflicting findings have been reported: some studies affirm there is an anti-public sector bias, others detect a preference towards public-sector providers, and some have found no evidence of a sector bias, pro or anti. We believe it crucially important to understand the mechanisms underlying sector bias, if it exists. To address the current research gap in this area, we make use of theories and tools drawn from neuropolitics (namely, functional Magnetic Resonance Imaging, fMRI) to elucidate the neurobiological foundations of perceptions regarding the performance of public-sector service providers. The neural findings obtained reveal that brain networks associated with reward and positive values provide a neurobiological explanation for pro-public sector bias, while neural mechanisms linked to aversion, risk, ambiguity and motivated reasoning are associated with an anti-public-sector bias. The implications of these findings should be considered by policymakers; for example, to promote acceptance of public-sector service provision, people must be clearly informed about the goals achieved and other positive aspects.

Keywords Neuropolitics · Sector bias · Functional magnetic resonance imaging · Performance information · Public and private sectors

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Introduction

Individuals' perceptions and attitudes regarding government, politicians and the provision of public services can impact directly on the political, social and economic well-being of society as a whole. In democratic political systems, citizens continually interact with government by voting, paying taxes, providing feedback on laws and services, and participating in the creation and consumption of public goods and services (Bastida et al., 2021; Vela-Bargues et al., 2021). If their perceptions of politicians and the public sector are negative, they might be motivated to evade taxes, choose private services over public ones, avoid working in the public sector (perhaps citing inefficiency and low morale) or even limit their cooperation with constitutional directives and cease to exercise their democratic rights (Garrett et al., 2006).

Various studies of political behaviour have assessed perceptions of government and the provision of public services but the results to date have been inconclusive. One widely-supported line of research seems to confirm the existence of a negative stereotype of the public sector, associated with low efficiency, inflexibility, an entangled bureaucracy and a lack of transparency (Battaglio Jr. et al., 2019; Yamamura, 2014). Such views may be derived from prior experience, personal beliefs or political ideologies (Baekgaard & Serritzlew, 2016). Indeed, studies have shown that these negative perceptions may be present not because of but despite the reality of public-sector performance (Marvel, 2015, 2016). The expression of negative attitudes towards the public sector even when confronted with evidence of satisfactory performance has been termed anti-public-sector bias, and has been detected in diverse settings (Van Ryzin, 2013). However, other studies not only have found no evidence of such a bias but have confirmed the existence of an anti-for-profit prejudice when the private sector is sub-divided into nonprofit and for-profit (Meier et al., 2019). For example, Meier et al. (2022), Meier and An (2020) and Hvidman and Andersen (2016) all support this view and argue that in certain sectors or institutions (such as universities or hospitals) there is not only a positive perception of public performance (as indexed by efficiency, justice and fairness), but also a negative evaluation of the performance of the private sector (i.e., an anti-private-sector bias).

Empirical studies of political behaviour have confirmed that the public–private sector divide is of decisive importance in the assessment of performance; in other words, individual biases influence the evaluation of public and private-sector performance. Building on these findings, to explore why and under which circumstances this sector bias occurs, would provide valuable information for analysts and policymakers. And in this regard, understanding the mechanisms underlying and provoking bias might constitute an important advance. Initial steps in this direction have been taken, in studies of the moderating effect on sector bias of social construction (Schneider & Sidney, 2009), the distribution of benefits (Garrett & Jansa, 2015) and the distribution of burdens (Davis, 2021). Despite this promising work, calls are being made for further study, focused on achieving an objective understanding of the psychological mechanisms generating and

maintaining sector bias. For example, although some studies have highlighted motivated reasoning as a factor that can bolster preexisting beliefs when faced by contradictory evidence, suggesting this may be the main psychological mechanism leading to sector bias (Taber & Lodge, 2006), others have emphasised the effects of reward and preference-related processes when individuals encounter attitude-congruent performance information, as a driver of sector bias (Weston et al., 2015).

Neuropolitics, or the use of theories, methods and assumptions of neuroscience to address political questions, is a promising new approach in political behaviour, by which researchers seek to identify the neuropsychological mechanisms that may determine sector bias (Jost et al., 2014). Unlike traditional experimental techniques such as discrete interval scales, questionnaires or focus groups, neuroimaging methods allow the researcher to capture the moment-by-moment, introspective and implicit reactions present during the evaluation of performance, while avoiding some of the limitations of traditional tools, such as subjectivity, social desirability or sensitivity to certain issues (Alford & Hibbing, 2008). The present study, to our knowledge, is the first to use a neuroimaging tool, namely functional Magnetic Resonance Imaging (fMRI), to explore the underlying neural mechanisms of public and/or private-sector biases within individuals. We hope that the results obtained will not only provide a deeper understanding of the introspective reasons for the phenomenon of individual bias towards the private and/or public sectors, but may also elucidate the specific neural processes by which individual perceptions affect the evaluations of public/private performance and, moreover, contribute to the design of more effective political strategies for enhancing society's perceptions of governments and of public-sector services.

Literature Review

Perceptions of Public and Private-Sector Performance

Many studies of political behaviour have analysed the generation and influence of perceptions of public and private-sector performance, highlighting the undesirable repercussions that can arise from negative evaluations of public institutions, in terms of government effectiveness and other economic and sociological consequences (Bovaird, 2007; De la Higuera-Molina et al., 2019). Following Perry and Rainey (1988), we define an organisation/sector as public if it is publicly owned, taxpayer funded and subject to a degree of social control, whereas private organisations are privately owned, funded by consumers or stockholders and market-profit driven (Bel & Fageda, 2010). A growing body of empirical research in this field suggests that many citizens consider the public sector to be inefficient, inflexible and burdened by administrative rules; consequently, the provision of public services is perceived as deficient and unreliable (Goodsell, 2013; King, 2014). In this respect, Van Slyke and Roch (2004) concluded that the citizens who are most dissatisfied with social services misidentify the ownership of the service provider as public (and not as private, whether profit or non-profit). In a related empirical study, Marvel (2015) detected

implicit negative stereotypes and traits (e.g., "slow") regarding a public service provider (in this case, the US Postal Service), compared to a private one (FedEx). Corroborating this conclusion, the public choice models examined by Lake and Baum (2001) confirmed that many citizens were sceptical of whether democratic government, exercising its legitimate monopoly of power, could meet their needs through the provision of public services.

Recent empirical studies have made great advances towards determining whether these negative perceptions of public services generate a corresponding bias in evaluations of public performance, i.e., the effectiveness achieved in terms of the quantity/quality of the results derived from the input of a given level of resources (Hvidman, 2019). In this respect, Hvidman and Andersen (2016) reported that Danish undergraduate students considered public hospitals to be less efficient and more bureaucratic than private ones despite equal levels of performance. Marvel (2016) examined attitudes toward public services when performance information was supplied by means of implicit association tests, and concluded that assessments of government performance were influenced by negative, preconceived attitudes towards public services. These studies confirm what Marvel (2015) called the anti-public-sector bias, that is, the expression of negative attitudes towards the public sector even when confronted with objectively positive public performance.

However, not all investigations of anti-public-sector bias have found evidence to support the phenomenon. In the context of in-home elderly care, Hvidman (2019) concluded that only those individuals with a negative general attitude towards the public sector manifested a negative performance evaluation. Similarly, Baekgaard and Serritzlew (2016) reported that assessments of the performance of Danish hospitals and schools were conditional on the individual's prior beliefs about the public sector. Meier et al. (2019) replicated the Danish hospital experiment in the US, but found no evidence of anti-public-sector bias in any of the performance measures used (efficiency, effectiveness, red tape and benevolence). In their study of nursing homes in the US, Meier, Song, Davis and Amirkhanyan (2020) divided the private sector into profit and nonprofit, and compared its performance with that of a public provider. Corroborating Meier et al. (2019), these authors recorded no significant differences among the service providers when performance information was facilitated. Nevertheless, they found favourable biases towards nonprofit and public performance, and negative ones towards for-profit homes, when no performance information was given. The findings of Davis (2020) in the field of university services and those of Meier et al. (2022) for nursing homes in the US, confirm the existence of an anti-for-profit-sector bias, with nonprofits and the public sector being perceived more favourably.

Several studies have proposed alternative explanations for the absence of unanimity regarding sector bias, such as dependence on the service context (Hvidman & Andersen, 2016), the influence of prior beliefs (Baekgaard & Serritzlew, 2016), the availability of corroborated and publicly-known data regarding private sector inefficiency (Meier et al., 2022) or even the evaluation of sector bias with the provision or otherwise of performance information (Meier, 2020). Most studies, nevertheless, confirm the existence of sector bias, although none have attempted to offer a deeper understanding of the psychological reasons for its existence. Accordingly, Marvel

(2016) called for further studies to be undertaken to elucidate the psychological mechanisms underlying sector bias.

Unveiling the Underlying Psychological Mechanisms of Anti-sector Bias

Why do people have negative perceptions of a certain sector and evaluate its performance in a biased way, even though they have previously been satisfied with the services delivered by that institution? (Goodsell, 2004). Studies of political science and psychology have suggested that a major source of bias is the influence of prior beliefs and experiences. For example, a negative public-sector stereotype may stem from a highly critical attitude generated by the media (Druckman & Parkin, 2005), politicians (Goodsell, 2004), long-term experiences with the public sector (such as government effectiveness or level of corruption) or even the individual's political ideology (Marvel, 2015). In contrast, other studies have observed a negative outlook towards the private sector and argue that, regardless of their lower prices, private providers do not offer better performance and are overly profit-driven, with no regard for fairness or citizen-centredness (Bel & Esteve, 2018).

Extensive research in psychology and political science suggests that individuals' prior experiences and beliefs shape the ways in which they interpret information, as they seek to maintain consistency between their evaluations of performance and their prior attitudes. This phenomenon has been termed motivated reasoning (Baekgaard & Serritzlew, 2016; Slothuus & de Vreese, 2010) and is related to classical theories in psychology such as confirmation bias and cognitive dissonance. In the context of pro or anti-sector bias, the concepts of motivated reasoning and confirmation bias suggest that when exposed to performance information to be evaluated, most individuals will base their judgments on the evidence most in line with their beliefs. A direct consequence of this is that individuals are likely to positively value and accept positive performance information that is consistent with their prior thoughts (Meier, 2020). In fact, some studies find that when citizens encounter attitude-congruent political information (such as positive performance information about a preferred sector), they perceive it as rewarding (Gozzi et al., 2010). In psychology studies, rewards are defined as positively balanced and valuable stimuli that can arouse approach behaviour (for example, the preference for a given service) (Porcelli & Delgado, 2009). Additionally, the selective perception associated with confirmation bias could encourage citizens not to notice, not to see as rewarding or to more quickly forget information that refutes their negative beliefs (for example, positive performance about the sector regarded in a negative light).

Confirmation bias is associated with another psychological concept of great relevance in this context, namely cognitive dissonance, which suggests that when individuals are exposed to several pieces of information that are inconsistent with one another, this provokes feelings of dissonance and the wish to make the information items more consistent (Festinger, 1962). In the context of sector bias, this could mean that when people have negative perceptions towards a sector and encounter positive information about it, they may experience cognitive dissonance and try to behave consistently by discounting the information that contradicts their thoughts

(namely, the positive data). Indeed, political research has found that individuals tend to discredit and perceive as ambiguous evidence that clashes with their initial beliefs (Marvel, 2015). Studies in the field of political behaviour corroborate this reasoning. It has been reported that individuals may even experience negative values, aversion and risk when evaluating attitude-incongruent information, such as that provided by candidates representing opposing political parties (Kaplan et al., 2007). Psychological research has defined aversion as a physiological reaction, with dislike as a stimulus, normally accompanied by withdrawal from or avoidance of the stimulus. The American Psychological Association (2019) defines negativity as a feeling stemming from failure to achieve a goal, the wish to avoid a threat or dissatisfaction with the current state of affairs.

Although these studies highlight cognitive and affective processes that may determine sector biases, to date no research has confirmed the existence of psychological mechanisms underlying bias in the evaluation of public and/or private-sector performance. In the present study, we aim to address this research gap, borrowing tools and theories from neuroscience to objectively capture introspective, implicit reactions produced on exposure to performance information regarding the public and private sectors. The following section elaborates on the concept of neuropolitics and develops the main research questions considered.

Neuropolitics: Exploring the Neural Bases of Anti-sector Bias

Origin and Added Value of Neuropolitics

Political behaviour and views have traditionally been considered solely the products of socialisation and of interaction with the cultural environment (Hibbing et al., 2014). However, and despite the considerable advances achieved in our understanding of behavioural and political science since the first studies in this area in 1960, questions such as the structure of political conflicts, the origin of animosity towards out-groups, the diversity of opinions on optimal strategies for determining resource distribution or the structure of group leadership, or even the main reasons underlying different political ideologies, have yet to be fully explained (Jost et al., 2014). The question then arises: what if political perceptions, evaluations and ideologies are, in fact, rooted in biology and evolution? This hypothesis is the fundamental basis of biopolitics, the branch of political science which proposes that the tools and theories of neuroscience, psychology and genetics, rather than traditional instruments such as linear regressions and surveys, provide a more objective and introspective perspective as a means of explaining individual behaviour and attitudes (Alford & Hibbing, 2008). Although studies of biopolitics have mainly taken a descriptive, theoretical and speculative direction since the inception of this approach, in recent years the scope has expanded dramatically, to reveal the psychophysiological underpinnings of political behaviour.

Madsen (1986), in one of the earliest studies in biopolitics, reported that dominance attitudes can largely be explained by the influence of serotonin (i.e., there is a genetic driver of belief). Subsequently, biopolitical studies borrowed techniques

from psychophysiology (such as eye-tracking, or measuring heart rate or skin conductance) to uncover the psychological origins of political behaviour. For example, Shook and Fazio (2009) reported that right-wing sympathisers paid less visual attention and were less engaged with information (as indexed by eye-tracking responses) when this information very probably contradicted their ideological beliefs. In another study, based on measurements of electrodermal activity, Dodd et al. (2012) found that persons with conservative rather than progressive beliefs expressed stronger physiological aversive responses towards certain social issues, especially sexual ones. Further investigations sought to reveal the physiological and non-verbal manifestations of political intergroup bias and its consequences (Cheon & Hong, 2016; Dovidio et al., 2006). More recently, groundbreaking advances have been made in neuroimaging tools such as functional magnetic resonance imaging (fMRI) and electroencephalography (EEG), which may contribute to explaining the innermost neural correlates of traditional constructs of great interest in political science, such as prejudice and stereotyping (Hart et al., 2000), in-group and out-group membership (Hein et al., 2007) and partisanship bias (Tusche et al., 2010). This novel focus of investigation has given rise to neuropolitics, an interdisciplinary field that tackles questions of interest to political scientists and psychologists alike, based on the methods, theories and assumptions of neuroscience (Casado-Aranda et al., 2020a, 2020b).

Although traditional survey-related techniques are often favoured by academics due to their ease of use, accessibility and cost effectiveness, their findings can suffer from biases such as subjectivity, social desirability and the impossibility of monitoring intrinsic emotional responses, i.e. motivated reasoning, thus stimulating positive or negative assessments (Battaglio et al., 2019; Hvidman & Andersen, 2016). Certain tools drawn from research studies into neuropolitics, such as EEG or fMRI, could overcome some of the above-mentioned limitations, by recording brain activations (indicative of implicit and unbiased neurocognitive responses) while participants are evaluating information (for example, on the performance of public or private-sector service providers).

Current Research

Considering the advantages offered by techniques drawn from neuropolitics, our study makes use of fMRI to characterise the neural mechanisms underlying the evaluation of performance information for the public and private sectors, and perhaps establish the neural foundation of anti-sector bias. fMRI was chosen for this task because it is the only neuropolitics instrument that can identify the deeper brain mechanisms related to decision making (such as reward, aversion, motivated reasoning or ambiguity), and because it is commonly used in political neuroscience (Jost et al., 2014). Appendix 1 describes the functioning of fMRI.

Following classical theories of the psychology of motivated reasoning and confirmation bias, we examine the notion that when individuals evaluate positive information about a favoured sector, they are likely to value it more positively and to perceive it as more rewarding than would be the case with similar information regarding a non-favoured sector (Baekgaard & Serritzlew, 2016; Gozzi et al., 2010). Given

these premises, it seems logical to assume the involvement of brain areas typically related to reward and personal values when individuals assess information aligned with their prior beliefs. In the context of private vs. public-sector preference, this alignment would be expressed as a positive sector bias (Proposition 1). Various studies and meta-analyses based on fMRI have pinpointed brain regions associated with positive values and reward sensations, showing that the reward processing circuit takes place in the ventral striatum, a brain region largely associated with favoured stimuli, concerning aspects such as the intake of appetising food (O'Doherty et al., 2002) or the observation (by an individual predisposed to favour fair trade products) of sustainable-product labels on the food consumed (Enax et al., 2015). The findings of a meta-analysis by Bartra et al. (2013) regarding the neural correlates of subjective values suggest that the ventral striatum is associated with positive subjective value and reward sensations. Similar positive sensations have also been recorded for the putamen and the anterior cingulate cortex (Bartra et al., 2013; Casado-Aranda et al., 2018; Hubert et al., 2018).

In contrast, and according to the theories of motivated reasoning and cognitive dissonance, when individuals are presented with information that is inconsistent with their prior beliefs (for example, positive data about a non-favoured sector), they may discount or reject it. In consequence, their evaluation of any such performance information should be considered as being at least ambiguous (Marvel, 2015). Similarly, the theory of motivated reasoning argues that when evaluating attitude-incongruent information (such as positive performance about a non-favoured sector), individuals would apply motivated reasoning, an automatic and heuristic process by which arguments that are inconsistent with their beliefs are rejected (Grimmelikhuijsen et al., 2017; Taber & Lodge, 2006). This negative predisposition towards a given sector could lead the individual to ascribe aversion, risk and negativity even when positive information about it is received (Grout & Alcock, 2010; Kaplan et al., 2007).

Overall, we expect that when individuals evaluate information about a sector that is perceived, a priori, to be inefficient, they are likely to experience ambiguity (i.e., they tend to discredit the information), motivated reasoning, perceived risk and negative value. Therefore, activations in brain areas related to ambiguity, risk, negative value and motivated reasoning are expected to be involved in the evaluation of information that is attitude-incongruent vs. that which is in line with preconceived attitudes (Proposition 2). In consequence, anti-sector bias will be revealed. In line with this rationale, neuroimaging research studies of the neural correlates of aversion and negativity have reported that the three extensive brain areas associated with these sensations are the amygdala, the angular gyrus and the inferior/superior/middle (orbito) frontal gyrus. The amygdala is strongly associated with emotional responses to sources of danger (Liddell et al., 2005) and with strong sensations of fear (Sengupta et al., 2016). Furthermore, a fMRI meta-analysis by Bartra et al. (2013) identified the amygdala with the subjective value of the penalty domain. Another meta-analysis, by Krain et al. (2006), of risk or ambiguous decision-making, suggested that the angular and the inferior/middle frontal gyri were related to the processing of risk and ambiguous stimuli. Numerous other studies, too, have corroborated the functions thus identified, as well as those of secondary regions such as the insula,

when evaluating risk (Casado-Aranda et al., 2018, 2019; Studer et al., 2014). As regards the motivated reasoning underlying brain expectations, of particular interest to our study is the fMRI analysis carried out by Westen et al. (2006), who first identified the neural correlates of motivated reasoning in the realm of politics, detected following the activation of the precuneus and amygdala during the processing of threatening/incongruent information.

Methods

Study Sample

Thirty participants were initially recruited for the fMRI test. Three were later excluded due to excessive movement during the scanning and one was excluded due to neurological abnormalities. Thus, 26 participants remained (13 men and 13 women), with an average age of 25.2 years (SD = 4.2 years). Each met the usual requirements for fMRI scanning (no metals in the body, no history of psychiatric care, no pregnancy). Prior to enrolling in the study, all signed an informed consent form, in compliance with the Helsinki Declaration and the requirements of the Human Research Ethics Committee of the University of Granada. The special characteristics of fMRI studies (i.e., significant cost and time, together with limited accessibility) restricted the potential sample size (Hedgcock & Rao, 2009). However, Solnais et al. (2013) concluded that a sample population of 20–25 subjects was sufficient for high-impact neuroimaging research (Guo et al., 2016; Casado-Aranda et al., 2019).

The fMRI Task

The participants were requested to arrive one hour prior to the experiment, in order to confirm the data recorded on the informed consent form and to ensure that all the medical requirements were met. Once inside the scanner, in a supine position, each individual was shown images of interest (40 with positive information related to public-sector services and another 40 with positive information related to private-sector services). The images were transmitted via a mirror onto a screen while the neural reactions were recorded. Each image was accompanied by realistic information on service performance, obtained from official sources (such as the Centre for Sociological Research). To avoid skewing the neural responses, the words "Public" and "Private" were only employed to refer to the type of service provided, not to the specific agency responsible. Unlike prior analyses in this field, which focused on the activity of a specific sector, such as healthcare (James & Van Ryzin, 2017) or the postal service (Marvel, 2015), our analysis is based on data for multiple services, thus enabling broader and more consistent results to be obtained.

In every case, the information observed was composed of 40 images of service provision (including electricity, community pharmacy, university education, civil protection and park maintenance), supplied by public and private-sector providers

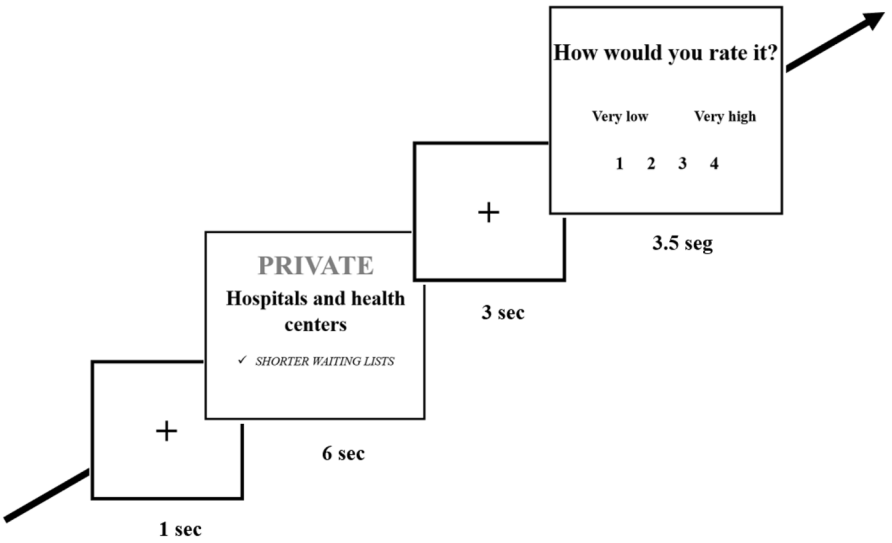


Fig. 1 Structure of the task (public/private performance information) viewed by the participants during the fMRI session

(i.e. 40 public; 40 private; n = 80 slices). The task had a total duration of 16 min (Fig. 1). For each image, 6 s of slice information was provided, followed by a 1–3 s on-screen display of the question "How would you rate its performance?". This question served as a self-reported analysis of perceived service performance, by reference to the sector provider. Responses were given in the scanner itself by pressing one of four buttons corresponding to a four-point rating scale ranging from 1 = definitely low performance to 4 = definitely high performance). E-Prime Professional 2.0 software was used to display the slides. On completion of the task, each participant received a payment of €30. Appendix 2 lists all the messages received by the participants.

Regions of Interest (ROI)

Appendices 3 and 4 detail the parameters of the image acquisition, preprocessing and fMRI procedures applied. The analyses of the brain ROI were run using small volume correction (SVC), implemented by Statistical Parametric Mapping software (SPM12, Wellcome Department of Cognitive Neurology, Institute of Neurology, London, UK), with Family-wise error rate correction (FWE) at p = 0.05. SVC allows researchers to conduct principled correction in accordance with the Gaussian random field theory within a predefined region of interest (Bennett et al., 2009). Specifically, we created a mask containing spheres of radius 10 mm based on anatomical coordinates derived from previous studies of the processing of positive evaluation and reward, negative valuation, risk, ambiguity and motivated reasoning (stated coordinate values refer to the ROI centre in the MNI space). It was therefore

possible to define the striatum as a ROI (− 8, 14, 2) based on the findings of the meta-analysis conducted by Bartra et al. (2013) to explore subjective reward evaluations. The negative evaluation process of the amygdala, another ROI identified by Bartra et al. (2013), is characterised by the coordinates 24, − 4, − 18. The psychological processes of risk and ambiguity were evaluated from the coordinates of the angular gyrus (52, − 54, 33) and the inferior frontal gyrus (46, 42, 6), respectively, in line with the decision-making meta-analysis conducted by Krain et al. (2006). Finally, motivated reasoning was characterised by the coordinates of the inferior parietal gyrus (− 22 − 4 − 12), identified by Westen et al. (2006) in their analysis of the neural bases of motivated reasoning.

As an exploratory consideration of the neural results obtained, we also implemented a whole-brain analysis, using a threshold of ten contiguous voxels at an uncorrected p value of 0.001, equivalent to a FWE correction of $p = 0.05$ (Casado-Aranda et al., 2018). This less strict approach enabled us to view the active areas of the brain above a specific primary threshold in each of the contrasts of interest. In these whole-brain voxel-wise analyses, the number of independent tests often runs into the hundreds of thousands. Nevertheless, relatively few observations (10–30) are obtained, which reduces their power.[1]

Results

The statistical analyses for this study were performed using IBM SPSS v.20 software. Wilcoxon's test was used to identify divergences in the evaluations of public vs. private-sector performance. The results obtained show that public-sector services were rated significantly more highly ($M_{public} = 3.1$; $SD = 0.44$) than those provided by private-sector organisations ($M_{private} = 3.6$; $SD = 0.62$) [$Z\ (26) = 2.06$; $p < 0.05$].

Fundamentally, this study explores the neural mechanisms underlying the processing of information on the service performance of public and private-sector suppliers. Our initial proposition was that a positive sector bias would be detected if reward- and positive value-related brain areas were strongly activated when the participant evaluated the performance information for a preferred vs. a non-preferred sector. Corroborating this Proposition 1, the ROI analysis revealed a heightened activation of the striatum, an area of the brain strongly associated with reward and value (Bartra et al., 2013), when participants assessed positive information about the performance of public vs. private-sector providers. In turn, positive information for private vs. public-sector performance elicited stronger brain activations in networks associated with negative values (amygdala), ambiguity and risk (angular gyrus and inferior frontal gyrus), and motivated reasoning (inferior parietal gyrus) (Bartra et al., 2013; Casado-Aranda et al., 2018; Liddell et al., 2005). These findings corroborate our Proposition 2, showing that an anti-sector bias not only leads the individual to discount information about a non-preferred sector, but also makes this

[1] Data, subjects' characteristics, onsets and steps for fMRI data analysis for the production of the analysis in this paper are available at http://hdl.handle.net/10481/74961.

Table 1 Brain regions identified by small volume correction (SVC, whole-brain with mask) and whole-brain (without mask) analyses of private and public-sector performance

Contrasts and regions	Peak MNI coordinates (mm)			Cluster size	T
	x	y	z		
Private vs. public sector					
SVC analysis					
Amygdala	24	− 4	− 18	8	4.21
Angular gyrus	52	− 54	33	7	4.65
Inferior frontal gyrus	46	42	6	2	3.53
Precuneus/inferior parietal lobe	2	− 52	18	7	5.72
Whole-brain analysis					
Inferior frontal gyrus	48	49	− 6	5	4.77
Middle formal gyrus	27	25	40	8	4.67
Angular gyrus	52	− 49	26	10	4.65
Superior frontal gyrus	− 29	63	12	6	4.26
Public vs. private sector					
Caudate nucleus/Striatum	− 8	14	2	4	3.98

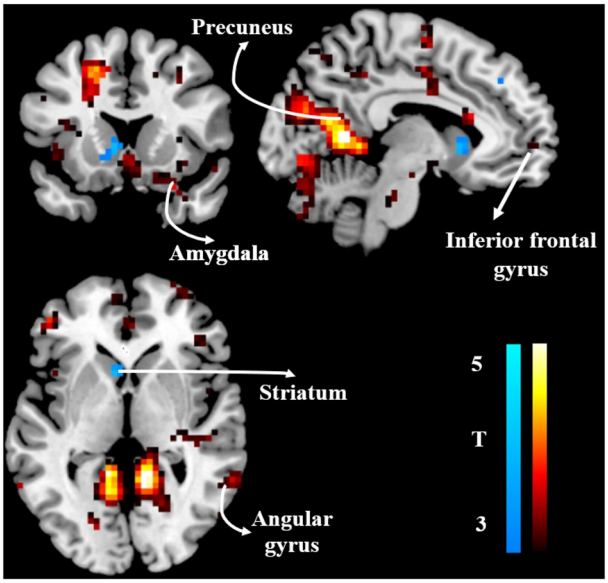


Fig. 2 Illustration of the whole-brain regions that are activated when viewing information associated with public/private-sector performance. Red: activation when viewing private > public data in the following ROIs: amygdala (Bartra et al., 2013), angular and inferior frontal gyri (Krain et al., 2006) and precuneus (Westen et al., 2006). Blue: activation when viewing public > private data in the striatum ROI (Bartra et al., 2013) (Color figure online)

information seem ambiguous or even negative and risky. The findings from whole-brain analyses, thus, bolster our propositions regarding psychological processes related to pro and anti-sector biases (Table 1; Fig. 2).

Discussion

Governments, political parties and public institutions regularly design communication campaigns praising their performance in terms of goals achieved, efficiency, quality and the fairness of public services. If this information is perceived as accurate and trustworthy, it would foster participation in democratic acts, compliance with tax obligations, the use of public vs. private products and services, and even the re-election of politicians currently in power. For this reason, researchers in the field of public administration have long sought a better understanding of how individuals evaluate service performance by the private and public sectors (James et al., 2016). In this respect, opinions are divided. Some studies report the existence of an anti-public-sector bias (Marvel, 2015), while others have observed opinions in favour of the public sector (Meier et al., 2022). According to Meier et al. (2020), the direction and degree of bias depends on the activity sector in question. It may even depend on prior individual experiences with a given sector (Hvidman & Andersen, 2016). In contrast, Hvidman (2019) found no evidence of any sector bias. We contend this lack of agreement is due to the fact that no previous studies have attempted to identify and evaluate the psychological mechanisms underlying the existence or otherwise of sector biases. To address this research gap, we make use of instruments such as fMRI and of theories drawn from neuropolitics, seeking to elucidate the neurobiological foundations of individuals' evaluations of information about the performance of private and public-sector providers.

Analysis of the participants' self-reports confirms their preference for public vs. private-sector service providers. In other words, there exists an anti-private-sector bias, as reported in prior research conducted in the contexts of nursing homes and university services (Davis, 2020; Meier et al., 2020). Our neural findings represent a significant advance in political behaviour research, revealing the underlying neural foundations that trigger the sector bias identified. According to our Proposition 1, the receipt of positive information regarding a sector aligned with the individual's beliefs would be perceived as valuable and rewarding and would stimulate reward-related brain regions. In line with these expectations, we found that the ventral striatum presented greater stimulation when public (vs. private) sector performance was evaluated. The role of this region of the brain in reward-based decision-making has been evidenced in many analyses, which have associated it, for example, with taste reward (O'Doherty et al., 2002), the visual inspection of preferred foods (Stoeckel et al., 2008), and the presence of fair trade labels on consumer products (when the individual favours this option) (Enax et al., 2015). Our results, moreover, corroborate the psychological theory of confirmation bias (Slothuus & de Vreese, 2010), according to which exposure to attitude-congruent information about a sector tends to confirm prior beliefs, which in turn foster acceptance of the information. We suggest that the confirmation bias towards positive information regarding the preferred

sector has a neurobiological foundation, in brain areas associated with reward and value. This understanding is of crucial importance, as previous studies have shown that the involvement of reward-related brain areas can impact on approach behaviour (e.g., preferences or choices) (Porcelli & Delgado, 2009). For example, the nucleus accumbens (an area of the brain typically associated with reward) may be predictive of music sales performance (Berns & Moore, 2012) or, in another field, the success of public health campaigns (Doré et al., 2020). Hence, the greater neural reward derived from evaluating information about the performance of a preferred sector could crucially impact on future choice.

Considering psychological theories of cognitive dissonance, in Proposition 2 we suggest that when persons who are biased against a sector (private or public) are presented with positive information about a service provided by that sector, they will be inclined to discount or reject this information contradictory to their opinions (Marvel, 2015). Furthermore, following Taber and Lodge (2006), we suggest that psychological mechanisms associated with motivated reasoning, negative valuation and risk would be reinforced on encountering attitude-incongruent information. In our study, the neural results obtained confirm these expectations and reveal, for the first time, that (private) anti-sector bias stems from neural processes linked to risk and ambiguity (the angular gyrus and inferior frontal gyrus), aversion (the amygdala) and motivated reasoning (the inferior parietal gyrus) (Bartra et al., 2013; Krain et al., 2006; Westen et al., 2006). Previous studies in social cognitive and affective neuroscience have concluded, for example, that the amygdala is strongly associated with the rejection of unreliable websites (Dimoka, 2010). In this context, too, Westen et al. (2006) observed similar inferior parietal coordinates when participants evaluated information that contradicted their prior beliefs, while Levy et al. (2011) confirmed that the activation of brain networks associated with risk and aversion reliably forecasted future product non-choices. Overall, previous research suggests that the neurobiological roots of an anti-sector bias could be indicative of the rejection and avoidance of the services offered by this sector.

The findings we report elucidate the neural origin of the sector bias presented by individuals asked to evaluate information regarding the performance of public and private-sector service providers. In particular, we show that areas of the brain associated with reward and positive value are neurobiologically associated with a positive sector bias (in the present case, favouring the public sector), while neural mechanisms linked to aversion, risk, ambiguity and motivated reasoning are responsible for an anti- (private) sector bias. These findings enhance our understanding of the field, as earlier studies have drawn conflicting conclusions regarding the psychological mechanisms underlying the presence or absence of biases towards the public and/or private sectors (Hvidman, 2019; Meier et al., 2022). Our approach better considers the neural expression of sector biases by including various fields of activity in the analysis, such as electricity, university education, health care and urban refuse collection, in contrast to previous research, focused on a single activity (Marvel et al., 2015). A second major aspect of the present study is that our self-reports and neural findings suggest the existence of negative private-sector and positive public-sector biases. The recent study by Meier et al. (2022) provides insights that may explain this result. These authors explain that the anti-for-profit bias observed in the

context of nursing home attention may arise from the fact that in the US (where their research took place) the superiority of public-sector nursing-home services is well known. In general, therefore, public providers are usually chosen in preference to private ones. These authors argue that a high level of knowledge and previous satisfactory experience would explain the anti-private-sector bias recorded. In Spain, too, citizens traditionally hold a positive view of the public sector and have extensive experience with it (Osur, 2018), circumstances that would tend to promote a positive sector bias (Taber & Lodge, 2006). The third important aspect of our study is that it represents a step forward in neuropolitics research, suggesting and providing evidence that the evaluation of service performance is neurobiologically rooted. Prior neuroimaging research, such as that performed by Casado-Aranda, Sánchez-Fernández, et al. (2020), Casado-Aranda, Venkatraman, et al. (2020)), revealed that political involvement and the economic context can both influence the interpretation of political messages regarding corruption and other issues, thus highlighting, for the first time, the psychological mechanisms by which individual characteristics may affect the processing of political messages. In this realm, too, Mitchell et al. (2006) concluded that judgments of the mental states of ideologically similar others facilitates self-referential processing, a cognitive mechanism that is related to enhanced persuasion and the self-relevance of stimuli. Finally, Zamboni et al. (2009) reported that conservative statements provoke inhibitory neural impulses.

For public-sector managers, the main implication of our findings is that service providers within the public sector (and, indeed, all service providers whose performance is approved of) should loudly publicise the goals achieved and other positive aspects of their performance, thus appealing to individuals' neural reward circuits and potentially influencing future choices of service provider, in their favour. At a practical level, our conclusions may provide public managers with a better understanding of citizens' perceptions, highlighting the role played by neural responses and suggesting that policy-making should be more oriented towards the end users of the service. Finally, at the political level, policymakers should take into account the administrative context and seek to ensure their political decisions are better perceived by potential voters.

The results of this study should be viewed with caution for several reasons. Firstly, the analysis focuses on a single country, Spain, where there is a strong tradition of preference for the public sector. Further research is needed to examine perceptions in other contexts and where different types of public administration may be found (such as English-speaking countries and Continental Europe), as these differences may influence neural evaluations of public and private-sector performance (Stillman, 1997). Studies have identified diverse cultural values and hence administrative cultures among countries where different models prevail (Rodríguez-Bolívar et al., 2015; Rutgers, 2001), thus impacting on relationships with the State and on how citizens view their public administrations (Kickert, 1997). Future studies should also attempt to corroborate the (neuro) psychological mechanisms underlying perceptions of public and private-sector service providers when no performance information is given; some researchers consider this to be a crucial factor in determining the evaluation made (Meier et al., 2019). Prospective studies should also be undertaken to study sector bias

using alternative neuropolitics instruments, such as EEG, skin conductance or electromyography, in order to provide a different biological perspective of the phenomenon. Finally, follow-up research may be necessary to explore the mechanisms underlying the evaluation of different performance measures, such as red tape, fairness or equality. As a final conclusion, the study we present is a pioneer effort, helping explain how biology influences preferences for the public (private) provision of goods and services.

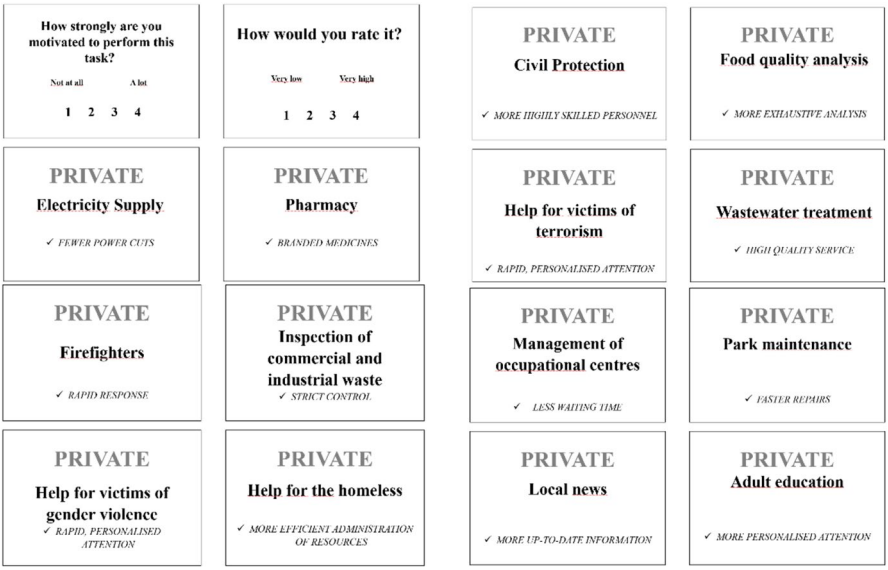
Appendices

Appendix 1: fMRI Functioning

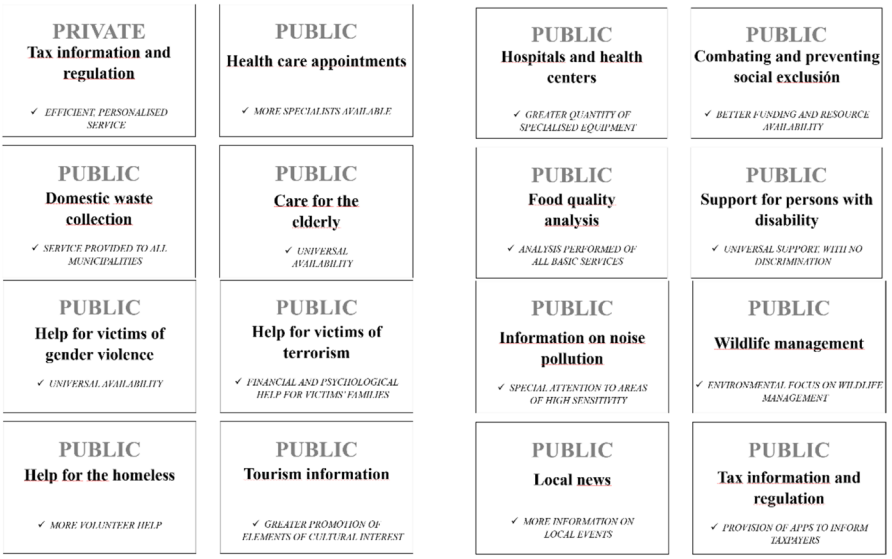
Functional Magnetic Resonance Imaging (fMRI) is a non-invasive scanning technique that detects changes in the level of blood oxygenation in the brain (namely the fMRI 's BOLD signal) derived from metabolic fluctuations of blood flow produced by the neural activation. fMRI researchers usually compare levels of activity stemming from different tasks within a region of interest. As specific regions of interest are linked to particular mental functions such as persuasion or attention (see Weber et al. 2015), the method is able to visually locate by means of MR brain images the neural origin of activations triggered by information (Casado-Aranda, Sánchez-Fernández, et al., 2020; Casado-Aranda, Venkatraman, et al., 2020). The fMRI technique is therefore an excellent means of assessing specific brain areas in high resolution (1 mm3) with an acceptable temporal resolution (1–3 s). Its main drawbacks are its high cost (the price for each participant is approximately €400) and the difficulty of recruiting enough participants, as they require strong incentives.

Image of functional Magnetic Resonance Imaging (fMRI) scanner

Appendix 2: Public and Private-Sector Performance




PRIVATE
Combating and preventing social exclusion
✓ GREATER CAPACITY TO DETECT POTENTIAL PROBLEMS
PRIVATE
Study room
✓ BETTER EQUIPPED FACILITIES
PRIVATE
Inspection of woodlands
✓ INSPECTION EVERY 3 DAYS
PRIVATE
Promotion of ecological awareness
✓ INTENSIVE INVOLVEMENT
PRIVATE
Sports facilities
✓ WIDER RANGE OF SPORTS FACILITIES
PRIVATE
Tourism information
✓ MORE UP-TO-DATE INFORMATION
PRIVATE
Medical appointment
✓ ATTENTION IN LESS THAN 5 DAYS
PRIVATE
Water Supply
✓ EFFICIENT SUPPLY OF HIGH-QUALITY WATER
PRIVATE
Hospitals and health centers
✓ SHORTER WAITING LISTS
PRIVATE
Care for the elderly
✓ SPECIALISED AND PERSONALISED SERVICE
PRIVATE
Attention for children at risk
✓ BETTER SOCIAL AND EDUCATIONAL INTEGRATION
PRIVATE
Waste Collection
✓ EFFICIENT WASTE COLLECTION AND TREATMENT
PRIVATE
University education
✓ BETTER JOB OPPORTUNITIES
PRIVATE
Healthcare
✓ SHORTER WAITING LISTS
PRIVATE
Primary and secundary education
✓ DIVERSIFIED, HIGH-QUALITY EDUCATION
PRIVATE
Guided tour services
✓ 100% PERSONALIZED SERVICE
PRIVATE
Information on air quality
✓ ACCURATE DATA
PRIVATE
Information on noise pollution
✓ ACCURATE, REAL-TIME DATA
PRIVATE
Information about waste
✓ ACTION TO RAISE AWARENESS ABOUT CLIMATE CHANGE
PRIVATE
Cultural events
✓ WIDE RANGE OF HIGH-QUALITY EVENTS
PRIVATE
Prevention of noise pollution
✓ ACTION TO PROTECT PHYSICAL AND MENTAL HEALTH
PRIVATE
Wildlife management
✓ ACTION TO ENHANCE QUALITY OF LIFE IN RURAL AREAS
PRIVATE
Musical events
✓ WIDE RANGE OF HIGH-QUALITY EVENTS
PRIVATE
Environmental protection
✓ ACTION TO COMBAT WILDFIRES AND ARSON


PRIVATE
Tax information and regulation
✓ EFFICIENT, PERSONALISED SERVICE
PUBLIC
Health care appointments
✓ MORE SPECIALISTS AVAILABLE
PUBLIC
Hospitals and health centers
✓ GREATER QUANTITY OF SPECIALISED EQUIPMENT
PUBLIC
Combating and preventing social exclusión
✓ BETTER FUNDING AND RESOURCE AVAILABILITY
PUBLIC
Domestic waste collection
✓ SERVICE PROVIDED TO ALL MUNICIPALITIES
PUBLIC
Care for the elderly
✓ UNIVERSAL AVAILABILITY
PUBLIC
Food quality analysis
✓ ANALYSIS PERFORMED OF ALL BASIC SERVICES
PUBLIC
Support for persons with disability
✓ UNIVERSAL SUPPORT, WITH NO DISCRIMINATION
PUBLIC
Help for victims of gender violence
✓ UNIVERSAL AVAILABILITY
PUBLIC
Help for victims of terrorism
✓ FINANCIAL AND PSYCHOLOGICAL HELP FOR VICTIMS' FAMILIES
PUBLIC
Information on noise pollution
✓ SPECIAL ATTENTION TO AREAS OF HIGH SENSITIVITY
PUBLIC
Wildlife management
✓ ENVIRONMENTAL FOCUS ON WILDLIFE MANAGEMENT
PUBLIC
Help for the homeless
✓ MORE VOLUNTEER HELP
PUBLIC
Tourism information
✓ GREATER PROMOTION OF ELEMENTS OF CULTURAL INTEREST
PUBLIC
Local news
✓ MORE INFORMATION ON LOCAL EVENTS
PUBLIC
Tax information and regulation
✓ PROVISION OF APPS TO INFORM TAXPAYERS

Appendix 3: Image Acquisition, Preprocessing and General Linear Model

The neural images of the different participants were recorded with a 3 Trio Siemens MRI Scanner. Images used to judge the performance of the public/private sector comprised 500 volumes. A T2*-weighted echo-planar imaging (EPI) sequence (TR = 2000 ms, TE = 25 ms, FA = 90º, 35 slices, slice thickness = 3.5 mm, slice order = descending) served for the functional images. Structural image T1 made use of a sagittal orientation and a voxel size of 1 mm^3 for coregistration and normalisation.

The data gleaned from the fMRI scanning were analysed using Statistical Parametric Mapping software (SPM12, Wellcome Department of Cognitive Neurology, Institute of Neurology, London, UK) scripted with MATLAB R2012a (The Mathworks Inc, Natick, MA). The functional images were realigned to the first image of the time series. The coregistration process consisted in matching images from the same subject that may be in different orientations, modalities, or acquired in

different scanning sessions. High-resolution structural images were then segmented (to produce a grey matter mask) and normalised (retaining 3.5 × 3.5 × 3.5 mm voxels) according to the template of the Montreal Neurological Institute (MNI). A Gaussian kernel (7 mm FWHM) smoothed the functional images.

A General Linear Model (GLM) for each subject was then generated with two regressors of interest: (i) onset picture of information as to the performance of the public sector (PUB), and (ii) onset picture of information as to the performance of the private sector (PRIV). Moreover, each GLM covered a constant session term, with six covariates to capture residual movement-related artifacts, fixation crosses and performance rating pictures as regressors of no interest.

The analyses of the neuroimaging data were first conducted separately for each participant, aiming to obtain individual brain activation maps (first-level analysis). The first phase of analysis consisted in calculating two contrasts: (i) public performance (PUB) minus private performance (PRIV) by applying a T-contrast to the first regressor of the model [1 − 1]; and (ii) private performance (PRIV) minus public performance (PUB), applying a T-contrast to the second regressor of the model [− 1 1]. This first level of analysis resulted in two contrast images for each subject. These individual activations were then aggregated by combining the normalised brain activations of all participants in the sample (second-level analysis). To define the brain regions that differed from the previous contrasts, the corresponding contrast images were analysed by one-sample t-tests in the second level random-effects phase. This practice is customary in neuroimaging studies in the social sciences (Casado-Aranda et al., 2018; Gearhardt et al., 2014). An explanation of the steps followed to conduct the fMRI statistical analysis is specified in Appendix 2.

Appendix 4: Analyses of fMRI Data

Based on the recommendations of Dimoka (2010) and Casado-Aranda et al. (2018), the fMRI data were first treated separately by each participant to obtain individual brain activation images (*first-level analysis*). The individual activations were then aggregated by merging the normalised brain activations of all the experimental participants (*second-level analysis*), yielding results reproducible to the whole population. This second-level analysis was implemented by considering the T-levels of the first-level analysis. However, they are not readily comparable because the absolute comparative levels differ greatly from subject to subject due to intersubject physiological variations, differences that are difficult to overcome due to the relatively small sample size of fMRI studies. Therefore, individual-level data are often analysed with fixed-effects models, and group data with random-effects models, to account for intersubject variability.

In this particular case we carried out a random-effects analysis, which facilitated the performance of different statistical tests, and then extrapolated the results to the study population:

(i) One-sample: to determine whether, on average, the activation level is significantly different from 0.

(ii) Two-sample: to determine whether the activation pattern differs significantly between two independent populations (e.g., patients-subjects)
(iii) Paired sample: to determine whether the activation pattern differs significantly between related populations. For example, in the same subject but at two different time points.
(iv) Multiple regression: to analyse the existence, direction and intensity of the relationship between the pattern of brain activity and a given quantitative variable (e.g., score on a symptomatic severity scale).
(v) Full factorial: to compare all the main effects and the interactions derived from the one, two- or three-way ANOVA.
(vi) Flexible factorial: usually used for ANOVA. Unlike "full factorial", this approach makes it possible to specify which main effects and interactions are to be analysed.

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