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Research

Comparing social representations of the landscape: a methodology

Carole Vuillot [1,2], *Raphael Mathevet* [1,3] *and Clélia Sirami* [4,5]

ABSTRACT. Social representations (SRs) are systems of values, ideas, and practices that characterize individuals' and social groups' relationships to both their social and natural environment. Comparing SRs between places, social groups, and through time is critical to understanding how social-ecological systems (SESs) and their diverse uses are perceived, interpreted, and understood. This knowledge needs to be taken into account to achieve efficient land use management of SESs such as agricultural landscapes. People's perceptions of the landscape are increasingly studied in sustainability sciences and a growing number of studies use the SR framework for analyzing differences in SRs between stakeholders and localities or for detecting changes over time. Robust methodologies able to compare SRs are required for this purpose. In this paper, we propose a modular approach to studying SRs from words collected from free listing tasks. This approach relies on standardizing definitions of frequency thresholds commonly used to assess SR content, consensus level, and structure. We then illustrate the value of this methodological approach through a comparative study of farmers' social representations of the agricultural landscape among four contrasted social-ecological contexts in France. We show how our comparative method allows for characterizing spatial variations in SRs and identifying social-ecological factors that influence the structuration and content of SRs. Finally, we discuss our methodological progress and the implications of our results for public policies aimed at managing SESs and in particular agricultural landscapes for conservation.

Key Words: *agricultural landscape; France; free-listing; mental models; quantitative analysis; regional environmental planning; social-ecological system; social representation*

INTRODUCTION

Land use planners and decision makers aiming to implement socially sustainable management of social-ecological systems (SESs) need to understand how the landscape and its diverse uses are perceived, interpreted, and understood (Buijs et al. 2011, Barreteau et al. 2016). Indeed, these perceptions, interpretations, and understanding shape the attitudes of the public and land users toward the landscape and its uses (Raymond et al. 2014, Plieninger et al. 2015).

To study these perceptions, several concepts have been developed, including ideology, attitude, mental models, and social representations (SRs). During the last 50 years, SRs have increasingly been used by scholars around the world, especially in Europe and South America, and have become a recognized field within social, cultural, and political psychology (Sammut and Howarth 2014), as well as sociology, anthropology, history, and geography (Flament and Rouquette 2003, Valence 2010). An SR is a "sociopsychological construct that performs a symbolic role, representing something - an object - to someone - a person or group. While doing so, the representation actually substitutes the object it represents, and therefore becomes the object itself, for the person or group that refers to it" (Wachelke 2011:730). The social representation theory (SRT) is a socio-psychological theory that focuses on the content and production of both common sense and knowledge, i.e., how people understand the world around them and the meanings they attach to that world (Moscovici and Marková 2000). The SRT aims to explain how different social groups develop different understandings of an issue based on their particular values, ideas, knowledge, metaphors, beliefs, and practices (Moscovici 1976, Sammut et al. 2015*a*).

The SRT has, for instance, proven useful to explain how social-ecological changes are perceived by nonexperts, and to overcome the opposition between an objective and a subjective perception of changes (Krien and Michel-Guillou 2014). Several studies have demonstrated the relevance of SRT in understanding inhabitant's or users' perceptions of change in SESs, such as changes in water quality in lagoons (Audouit et al. 2019), flooding risks in coastal areas (Lemée et al. 2019), ecosystem services in periurban areas (De Vreese et al. 2019), land use in rural landscapes (Anderson et al. 2017), conflicts in national parks (Buijs et al. 2011), rural development in alpine grassland landscapes (Quétier et al. 2010), and adaptive comanagement in recreational mountain landscapes (Lai et al. 2016). These studies show how existing SRs of the landscape and/or the SES dynamics shape beliefs about land use (Anderson et al. 2017).

SRs are organized and socially developed opinions that reflect common knowledge about a given object; they are based on experience and social interactions with others (Moscovici 1976). The assumption that all SRs are developed through communication is central to SRT (Buij et al. 2011). And, in return, SRs shape communication. For instance, SRs of SES shape communication about valuations of SES dynamics, strategic decisions, and actions (Quétier et al. 2010, Buijs et al. 2011, Blicharska and Van Herzele 2015). SR functions range from taking ownership of the environment through symbolic elements specific to the groups to which people belong (Roussiau and Bonardi 2001) to justifying positions and behaviors (Abric 2001*a*, Michel-Guillou and Moser 2006). When an object is new in the social arena and/or represents a new issue for a social group, the group develops SRs of this object (Moliner and Abric 2015). SRs mediate social groups' place-dependent relationships to their social and natural environment (Luginbühl et al. 2015). They

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contribute to building a consensual representation of the environment, and drive changes in worldviews and behaviors (Moscovici and Marková 1998). Consequently, SRs are key to understanding different stakeholders' viewpoints in order to achieve efficient land use policies (Gilg 2009).

Although SRs of SESs are increasingly studied in sustainability sciences and land use sciences (e.g., Conrad et al. 2011, Anderson et al. 2013, 2017, Moloney et al. 2014), our understanding of SRs dynamics is still scarce, either in time, e.g., in a dynamic SES, or in space, e.g., between places with contrasting land management policies. Yet, such understanding is key for scientists focusing on natural resource management, biodiversity conservation, or sustainability sciences. Indeed, they need to understand not only the social-ecological dynamics and the construction of knowledge, but also the dynamics of SRs to understand the social-political constructions, how they (re)construct social relations, and offer possibilities for different social-ecological trajectory. In order to gain this understanding, comparative approaches between localities or over time are necessary. However, such comparative approaches require being able to elicit SRs and compare them in a standardized and efficient way. In a previous article, we elicited and made a comparative analysis of individual interviews to explore relationships between farmers' individual mental models of the agricultural landscape and their land management practices in a case study located in Southern France (Vuillot et al. 2016). The present article builds on the previous one and proposes a methodological approach to elicit and compare SRs between places. First, we provide a critical introduction to the SRT, which briefly explores its utilities and weaknesses and then focuses on the structural approach of SRs. Second, we propose an innovative standardized and modular approach to studying SRs from words collected from free listing tasks. This approach consists in (i) identifying the content of SRs through a standardized threshold definition protocol and (ii) analyzing the structure of SRs through a rank-frequency analysis. It allows comparing SRs content, structuration degree, i.e., consensus level, and structure, i.e., identifying core and periphery. Third, we illustrate the value of such a methodological approach to compare farmers' SRs of the landscape among four contrasted rural SESs in France. We show that it helps understanding the spatial dynamics of SRs and identifying social-ecological factors that influence the structuration degree and the content of SRs. Finally, we discuss our methodological progress and the implications of our results for public policies aimed at managing SESs, and in particular agricultural landscapes, for conservation.

A CRITICAL INTRODUCTION TO THE SOCIAL REPRESENTATION THEORY

Why study social representations?

The concepts of ideology, attitude, mental models, and SRs are widely used in social psychology, sociology, human geography, or environmental sciences to study social phenomena, behaviors, and social practices of individuals or groups of actors. However, these four concepts have been developed separately, and only poorly integrated to each other. We believe that the lack of integration between these concepts may have undermined the development of SRs.

According to Rosanvallon and Viveret (1977, as cited in Jodelet 1991), it is often not the world that changes but rather its representation that constitutes a potential obstacle to the implementation of a new public policy. The concept of ideology (beliefs, values, norms) would then be insufficient to account for the relationship that is established between practice and SRs. Ideology is more and more often replaced by the concept of political culture or social values, i.e., "standards that people use to evaluate goals, entities, behaviors, and state of affairs as desirable, non-desirable, acceptable etc." (Tsirogianni et al. 2014:1809). It refers to a mixture of theoretical, practical, event-driven, and mythical elements organized around a dominant representation of social change. Aiming to describe the production of meaning and the relationships of meanings existing between different dimensions, i.e., economic, political, family, religious, etc., researchers define these elements as representations and seek to link them to effective practices.

The concept of attitude, i.e. the positive or negative orientation of the individual regarding the object, is used by action-oriented social sciences because it allows for the evaluation of an object in its affective, cognitive, and conative dimensions (Bergamaschi 2011). An attitude is the psychological evaluation of an object according to a degree of favor or disadvantage that integrates social values, i.e., which describe our ideas about a good life. It shapes behaviors and possible changes in it. However, many authors consider that the origin of attitudes is external to the individual (Deconchy 2003). Thus, attitudes and SRs are closely correlated variables, so it is within SRs that the individual's evaluations of social phenomena—his or her attitudes—are shaped. The joint study of SRs and attitudes is likely to anchor the latter in the web of social relations that characterizes a given context (Bergamaschi 2011).

Exploring human cognition dimensions that could explain preferences, actions, and behaviors is also a growing field in natural resource and SES management (Lynam and Brown 2011). The concept of mental model, as internal representation of external reality, is extensively used with a high diversity of meanings and methodologies as well as an important concept across a variety of academic disciplines (Jones et al. 2011). In this paper we seek to add to the synthesis of Jones et al. (2011), what we started to explore a few years ago (see Mathevet et al. 2011, Lynam et al. 2012, Vuillot et al. 2016): considering the mental model concept as an SR because the latter is developed by an historical social process, communication, and dissemination of knowledge systems (Moscovici 1988, Wagner and Hayes 2005). Socio-cultural knowledge, shared by a community, forms the common basis of all SRs of all groups in that community. Each group can develop specific knowledge based on the ideology, the social practices, and discourses of its group, which are contextualized and specified in mental models. These mental models are the mental constructs that control discourse, interaction, and other social practices. Reciprocally, it is through mental models that discourses can influence and reproduce SRs (Van Dijk 2006). When using mental models, different dimensions or sets of statements are stressed according the different disciplines (Barsalou 2009, Jones et al. 2011), and as we suggested earlier (Lynam et al. 2012) cognitive dimensions of social-ecological systems are key and little-discussed components of these complex systems, and the structuralist theory of SRs (Abric 2001*b*, see above) is beneficial in making sense of the multidimensional subject area associated with the concept of mental model. Therefore gaining a better understanding of how

SRs represent complex and dynamic SES and how they change according place and time could allow researchers and practitioners to develop more efficient management and use of natural resources and also more effective valuations of our social-ecological interdependencies (Mathevet et al. 2016).

Overall, the work of social psychology showed that (i) a cognitive perspective, i.e., based on individual mental models, that is too "intra-individual" does not allow the articulation to social and historical contexts; (ii) the concepts of ideology or attitude under which some may classify SRs fails to provide the framework for a detailed reflection on social cognition (Jodelet 1991). It is this deficiency that Moscovici (1976) wanted to overcome by articulating these concepts and promoting the concept of SR as we will see in more details thereafter.

What are social representations?

SRs are about "processes of collective meaning-making resulting in common cognitions which produce social bonds uniting societies, organisations and groups" Höijer (2011:3). As a social psychology theory, SRT links individual and society, managers and users, society and environment, and helps to understand what is perceived as common sense. Developed on the basis of Durkheim's seminal work at the end of the 19th century, i.e., Durkheim calls "collective" rather than "social" representations "the way in which that special being, which is society, thinks about its own experience" (Durkheim 1968:621), the theoretical framework of SRs was mainly nurtured by sociology, social psychology, and anthropology. The very concept of SR has been the object of several definitions since the 1960s (Moscovici 1972). SRs are the "outcomes of processes of communication that represent reality for a given people, and once in existence they constitute social reality *sui generis*" (Sammut 2015:104). We will keep in mind that an SR is "... an organized set of opinions, attitudes, beliefs and information referring to an object or a situation. It is determined both by the subject himself (his history, his experience), by the social and ideological system into which he is inserted, and by the nature of the links that the subject maintains with the social system" (Abric 1989:188).

An SR is then the result of an interaction between the individual, the social, and ecological world that surrounds him and the position he occupies in this world (Abric 2011). According to Flament and Rouquette (2003), social thinking can be described by four more or less integrated dimensions with a high degree of intra- and interindividual variability. These dimensions are the following: ideologies, social representations, attitudes, and opinions, i.e., view or judgement formed about something, not necessarily based on any fact or knowledge. But because the limits between what we think, what we know, and what we believe is often blurred, an SR is an organized and structured set of cognitive elements (opinions, information, beliefs) relating to a social object (Moliner et al. 2002). The conditions for the existence of an SR of a given object are not always met. The object must be important to individuals, it can be a potential threat or a particular interest, and it must be abstract or generic (Moliner 1993). Furthermore, the object must be present in the relations and communications between members of the social group, in a way that it carries a stake and participates in the social dynamic (Flamant and Rouquette 2003).

For Jodelet (2003) an SR entails three dimensions: information, field, and attitude. Information consists of an individual's knowledge about the object, this knowledge influences both individuals' image of a particular situation and individuals' behavior in reaction to this situation. Field corresponds to the way individuals organize their knowledge about the object. Attitude determines both the selection of information and its hierarchy in the field, shaping action and behavior (Sammut et al. 2015*b*).

Two mechanisms contribute to SR development, i.e., allow the social to transform an object and then the representations to transform the social. The "objectivizing process" selects the information that will be retained after individuals' beliefs and values filtration. The selected elements form what is called a figurative core. At the end of the transformation, the core acquires the status of evidence and becomes reality, a "common thought." The "anchoring process" makes it possible to integrate the object that is represented into a pre-existing system of thought. The social anchoring then confers a specific meaning, on what is familiar, on the elements (Herzlich 1972, Jodelet 1991, Wagner et al. 1999).

SRs occupy a place both upstream and downstream of action (Abric 2011), they achieve four functions in social dynamics and practices: (i) a knowledge function, to understand and explain reality by taking into account its values and framings ; (ii) an identity function, to characterize and preserve the identity of the group, by situating the group's membership and its members in the social field; (iii) a guidance function, to guide behavior, practices, and action; (iv) a justification function, to justify positions and behavior a posteriori.

Different methods of data collection do exist for the elicitation and study of SRs (Table 1). Discourse-based methods, e.g., semidirective interviews, questionnaires, scenarios, images, and drawings, are usually used, but methods specifically developed to study SRs have become widespread in the last two decades, such as free listing methods (Abric 2003, Flamant and Rouquette 2003, Moliner and Abric 2015).

Overall, the concept of SR is increasingly used in many disciplines and is becoming for some authors both a "buzzword" or a boundary-concept that allows different disciplines to work on a common topic. Despite its constant attraction for social scientists, the concept is controversial, like any developing theory. Criticisms often put forward the lack of an operational definition of SR, as well as the lack of an adapted methodology to study it (Farr 1991). However, over the last two decades, several studies have clarified the definition of SR (Abric 2011), and developed specific methods to study it (Guimelli and Rouquette 1992, Doise et al. 1993, Moliner and Abric 2015). Readers are invited to consult Voelklein and Howarth (2005) and Sammut et al. (2015*b*) to explore in detail how researchers have engaged a critical dialogue to improve the theoretical framework. For the sake of brevity, only two important points from these debates are presented below.

Controversies over social representations

First, most criticisms are often based on misunderstandings about concepts because they have different meanings in different disciplines or different languages and cultures. Several authors have suggested that there is a misunderstanding about the concept of SR because "social" can be understood as a form of consensus shared by members of a group about a particular object (Voelklein and Howarth 2005). However, seminal works have shown that

Table 1. Pros and cons of the main data collection methods used in the studies of social representations (SRs; from Moliner et al. 2002, Flament and Rouquette 2003, Jodelet 2003, Abric 2011, Moliner and Abric 2015).

Method type	Method name	Advantage	Inconvenient
Discourse-based	Document-based study	Inform on existing SRs independently to the research. Inform the context of expression of SRs and facilitate comparison according groups and over time.	Corpus elaboration usually time consuming. Subjectivity of qualitative discourse analysis. Quantitative discourse analysis skills.
	Semistructured interview	Partial structuration of the discourse. Describe existing SRs.	Speech bias. Context of the interview shape content. Perceived objectives of the interview influence content. Perceived status of the interviewer shape content. Subjectivity in the content analysis. No direct access to internal structure of the SRs.
	Questionnaire	Standardize method. Quantitative analysis.	Need initial surveys to design the questionnaire. Subjectivity and skills in the choice of questions. Speech bias. Statistical analysis of small or large samples.
	Fictive and problem-solving scenarios.	Collection of a lot of individual and collective reactions after the reading of a short text describing a fictive but credible context.	Selection and writing of the scenario. High cost of preparation with preliminary surveys.
	Drawing and/or use of inductive images.	Highlight key elements of SRs. Easy access to the signification of SRs. Easier identification of core elements.	Psychological interpretation skills of drawings. Subjectivity of the interpretation.
SR-based	Free listing (and related submethods).	Facilitate identification of implicit components difficult to access with interviews. Direct access to the core elements of the SRs.	Choice of inductive words is critical. Difficult to analyze without more elements regarding the general and specific context of the interviewees. Critical choice of the levels for the ranking and frequency thresholds to define core vs peripheral elements of the SRs.

representations are "social" because they are created and validated collectively, through communication and social interactions. Their content and specific form are influenced by historical and economic contexts as well as by social practices and cultural context (Moscovici and Marková 2000).

Second, critics tend to reduce the SRT to the influence of society on the individual, i.e. the effects of culture on cognition, therefore overlooking the fact that the SRT emphasizes the symbiotic relationship between culture and cognition. Many criticisms focus on the difficulty in understanding and integrating the complex, dynamic, and dialectical relationship between individual agency and social structure that constitutes the core of the SRT. According to Moscovici (1976), ideology, science, and worldview cannot capture the psychological organization of knowledge produced by society. Therefore, in an attempt to integrate sociological and psychological aspects, he developed the concept of SR, which is distinct from notions such as opinion, attitude, and stereotypes (Jodelet 2003, Voelklein and Howath 2005). Other criticisms focus on the complex and dynamic relationship between social structure and individual agency that he has put forward in theory. It is this dialectical concept of social life and social cognition that contrasts sharply with the Cartesian dualism that structures social psychology (Moscovici and Marková 2000, Farr 2003).

According to Voelklein and Howarth (2005), these criticisms make the SRT difficult to integrate into American and British social psychology, in which the relationship between the psychological and the social is analyzed through a separation of individual perception and cognition on the one hand, and culture and social context on the other. The unusual position of SRs between individuals and societies in which they live has led to critiques of social determinism and cognitive reductionism (Howarth 2006). This is why, for the majority of authors using the SRT, the latter constitutes the opposite reflexive pole to the dominant social psychology, which is said to be individualistic, behaviorist, and experimental (Potter and Wetherell 1998, as cited in Voelklein and Howarth 2005).

The structural approach of SRs

Among the various approaches available to study SRs, the structural approach represents one of the main developments of the theory (Wachelke 2011, Lo Monaco et al. 2017). In contrast to more anthropological socio-psychology approaches (e.g., Jodelet 1989), the structural approach has led to the development of semiquantitative methodologies. Although most studies and books have been published in French, this approach to SRs is increasingly available to an international English-reading audience (Wachelke 2011). In this approach, SRs lie in the symbolic and semantic universe associated with a subject that is shared by people within a social group. Studying SRs requires defining what are the symbols and meanings associated with a subject consensual enough to be part of the SR.

One of the most frequently used methods to elicit the content of SRs relies on free association tasks (Dany et al. 2015) as they allow for accessing the latent semantic universe associated with the studied subject (Abric 2003, 2011, Dany et al. 2015). Respondents are asked to give the first words that come spontaneously to their minds when hearing an inductor item, in the order that these words come to their mind until it becomes necessary to search for

words. Some studies set a priori a total or a maximum number of items to be uttered (e.g., Dany et al. 2015) and may ask the respondent to rank the items after the spoken phase. Uttered items can be words or short groups of words but must not be sentences.

To identify the content of SRs, we must be able to distinguish uttered words that belong to the shared semantic universe among people in the studied social group, hereinafter called "consensual words," from words that reflect individual or smaller subgroup viewpoints. Measuring the proportion of consensual words among all the words uttered allows (i) assessing the degree of structuration (Jeziorski 2014) of SRs and (ii) evaluating whether the SR is emerging, stable, or challenged by new socio-environmental conditions (Moliner et al. 2002). To our knowledge, there is no agreement in the literature on how to define the appropriate frequency threshold that allows for differentiating consensual words from other words (Alessio et al. 2011). This was identified as a major methodological challenge by Lo Monaco et al. (2017) and remains an obstacle to comparative analyses of studies based on free-listing tasks and rank-frequency analysis.

After selecting consensual words that represent the content of the SR, the second step consists in exploring its structure. The structure of SRs can be broken down into two components: a "central core" and a "peripheral system" (Abric 1994). The central core includes a limited number of words that correspond to the most stable elements of an SR, giving it its long-term continuity (Elands and Wiersum 2001) and its stable and most widely shared meaning (Dany et al. 2015). In contrast, the peripheral system includes words that are more sensitive to contextual variations; it allows an SR to be dynamic and to adapt through space and time (Moliner and Abric 2015). Focusing on the structural approach of SRs we present below a methodology to allow a robust analysis and comparative approach of SRs according time and SESs.

PROPOSED STANDARDIZED APPROACH

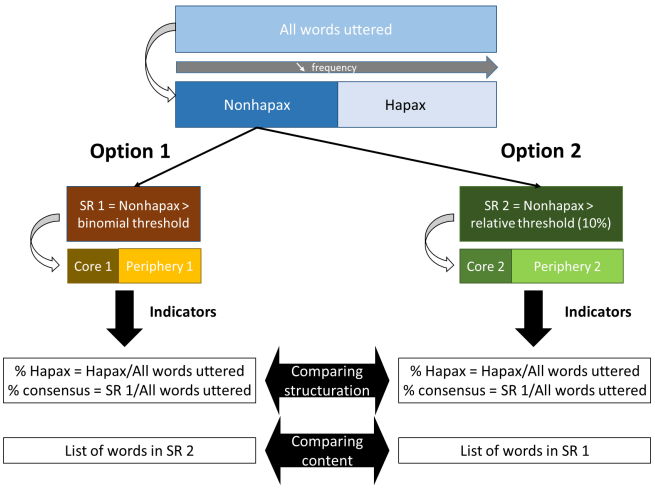
Selecting words belonging to the SR and measuring consensus

To distinguish consensual words from other words, researchers most of the time use arbitrary relative thresholds, e.g., words uttered by 10% or more of the interviewed people (Alessio et al. 2011, Wachelke and Wolter 2011). However, this approach does not allow for robust comparisons of the content and structuration degree of SRs between studies.

In order to determine the frequency threshold above which words are considered consensual in a quantitative and absolute way, and to make studies rigorously comparable, we propose to use an adapted version of the binomial test developed by Salès-Wuillemin et al. (2011). The binomial test determines for each word whether it is more frequently cited than it would have been if respondents had randomly picked up words from within the intra-site pool of words associated to the inductor word (with a type I error $\alpha = 5\%$). We can simulate the random distribution of uttered words by adapting Salès-Wuillemin et al. (2011)'s model to interview designs where there is no limitation to the number of words a respondent can utter (details on the model are provided in Appendix 1). We then test each word to determine whether its citation frequency is greater than the $(1-\alpha)$ quantile of the model (consensual word) or lower (nonconsensual word). In contrast to previous studies, we strongly advise checking for false positive detection rates, i.e., the risk of identifying a word as consensual when it is not, using Holm-Bonferroni p-value adjustment technique for multiple test procedure (Holm 1979).

This method is based on a very conservative definition of consensus and, consequently, when sample sizes are low and/or when SRs are not well structured (for example when they are emerging), the number of consensual words can be very low, even nil. Considering this, we propose a modular approach that distinguishes two options that remain comparable thanks to a few common indicators (Fig. 1).

Fig. 1. A modular step-by-step approach to measure and compare social representations through free listing interviews and rank-frequency analysis. BT = Binomial Threshold.



The first option is well adapted to cases where the sample studied is large and/or the data exploration shows that the social representation might be highly structured. Researchers can then focus only on consensual words to study the structure of the representation (e.g., Salès-Wuillemin et al. 2011). In that case, we suggest displaying and discussing other words (except hapax, i.e., words uttered only once) in an appendix to allow for qualitative comparisons with other studies with lower sample sizes.

The second option might be necessary in a case where the sample studied is small and/or the data exploration shows that the social representation might not be very structured, e.g., an emerging social representation. Then, the SR contains very few consensual words and researchers need to study the less frequently uttered words that may reveal trends in the development of the representation. In this case, following several authors (e.g., Vergès 1992, Morlot and Salès-Wuillemin 2009, Alessio et al. 2011, Jeziorski and Ludwig-Legardez 2013), we propose not only to consider consensual words defined through the binomial test but also to include all items uttered by at least 10% of respondents within a social group and on a site in order to study the structure of the representation. However, among these items, consensual words defined through the binomial test have to be clearly identified in order to allow for comparison between studies.

In both cases, two indicators can be used to measure the structuration degree of the social representation (Salès-Wuillemin et al. 2011): the proportion of consensual words and the

proportion of hapax, i.e., words uttered by one single respondent (Lebart and Salem 1988). The definition of a hapax is straightforward and the proportion of hapax can therefore be unambiguously compared between studies. This proportion is however seldom mentioned (but see Salès-Wuillemin et al. 2011). We strongly recommend calculating and displaying both indicators. These indicators can be statistically compared between studies using Chi square tests or Fisher's exact tests for count data.

Prototypical rank-frequency analysis

After consensus and variability levels have been assessed, the structure and content of social representations are most commonly studied though prototypical analysis followed by a categorical analysis of the words (Vergès 1992, Vergès et al. 2002). Prototypical analysis aims to distinguish within consensual words those that belong to the central core from those belonging to the periphery of the social representation according to their evocation frequency (the number of times a word is cited in a given study site) and utterance ranking. Higher frequency indicates a highly shared word, whereas first rankings indicate a word with a high cognitive availability (Dany et al. 2015). Crossing these two indicators allows for identifying salient words more frequently cited than the median evocation frequency and cited by respondents with a smaller rank, on average. These words are likely to be part of the central core of the social representation. In contrast, other combinations of levels of frequency and rank define words belonging to the periphery. Within these, frequent and later ranked words are considered unstable and prone to change part of the representation, whereas less frequent and earlier ranked items are likely to be redundant or to specify the central core. Finally, less frequent and later ranked items are not very important in the current representation but likely to become more so in case of adaptation to a change (Moliner et al. 2002, Michel-Guillou and Moser 2006).

Categorical analysis

Categorical analysis consists in grouping together semantically close words in broader themes. This step is defined by Vergès as a "merger between the researcher's own categorization system and what seems to emerge from the data" (Vergès 1992:204 [author's translation]). This step involves the researcher's subjectivity in defining the themes and can be quite difficult because some words can intersect several themes (Vergès et al. 2002, Conrad et al. 2011). This stage must be seen as an interpretative step that is essentially part of the analysis and allows an easier comparison between sites. The categorical evaluation grid has to be the same across study sites to allow for comparing representations across sites. It should be established for all items by the same researcher and crosschecked by at least one other person for consistency. To make meta-analyses feasible, a table showing the categories and the words they regroup must be displayed in all articles using categorical analysis (see Appendix 1, Table A1.1).

STUDY CASE: COMPARING FARMERS' SOCIAL REPRESENTATIONS OF "LANDSCAPE" ACROSS SESs

As highlighted in the European Landscape Convention, our society increasingly considers landscapes as SESs. Agricultural landscapes are the visible outcomes of long-term interactions between human activities, mainly agriculture, and the environmental action (Gibon 2005). Today, the search for sustainable agriculture and wise use of natural resources raises questions on the best ways to conciliate food production and biodiversity conservation in farmed landscapes (Tscharntke et al. 2005, Mathevet et al. 2014, Pe'er et al. 2014, Plieninger et al. 2015, Sirami et al. 2019). The European Landscape Convention (European Council 2000) advocates public participation in defining public policies for ecologically sound agricultural landscapes. In this context, research on farmers' social representations of the agricultural landscape promises to improve our way of thinking about and designing conservation policies in farmed landscape.

According to Moscovici (1976), social groups build SR of an object when three processes occur: first, when information on the object is dispersed through various channels and there is no orthodoxy on the object's meanings; second, when the social group needs to focus on part of the semantic universe associated with the object in order to master the object in a way that maintains the identity and cohesion of the social group; third, when there is external pressure on the social group to develop a discourse on the object, leading the group to infer the lesser known aspects of the objects. Therefore, considering (i) the polysemy of the term "landscape," (ii) the agricultural landscape being increasingly an issue in the public sphere, challenging farmers' identity and role, and (iii) the evolution over time of its acceptance in public policies (Swaffield 1991, Buijs et al. 2006), we assume that the agricultural landscape is an object of social representations among farmers. Moreover, we consider that regional contexts, especially differences in the local public policies, are likely to influence farmers' representation of the agricultural landscape.

We sought to determine to what extent the representation of the agricultural landscape was derivative from what is commonly understood about landscape and whether a distinctive representation of agricultural landscape had emerged amongst farmers. It must be noted that, in French, the word *paysage* means both landscape and scenery, i.e., an aesthetic dimension is embedded in the term whilst not defining it entirely. It is thus important to see what dimension will be emphasized in farmers' SRs of the agricultural landscape across different contexts.

The differences between microregions in the local importance of issues associated with the agricultural landscape and the local variety of stakeholders involved in such issues may especially have an effect on the content of the representation and the level of consensus. We consider that local landscape management policies are likely to bring farmers closer to the social subject agricultural landscape. Previous research has shown that the distance to the object of representation, i.e., the level of practices, knowledge, and engagement of the individual toward the object of representation (Dany et al. 2015), influences the consensus level, structure, and content of the representation (Galand and Salès-Wuillemin 2009, Morlot and Salès-Wuillemin 2009, Salès-Wuillemin et al. 2011).

Based on these studies, we can hypothesize (H1) that the level of local public policies dealing with agricultural landscape related issues has an impact on the proportion of consensual words as well as on the content and structure of the social representation. In this context, we made a first prediction: (P1) we will find a greater proportion of consensual words and smaller proportion of hapax in study sites where landscape issues are advertised and

Table 2. Characteristics of the four study sites. Source: Agreste 2000 (French national agricultural statistics). UAA = utilized agricultural area.

Study site	Area (km²)	UAA (%)	Mean UAA/ holdings (ha)	Arable land with cereals (%)	UAA with permanent grasslands (%)	Maintenance or implantation of linear elements (hedges, low wall, trees) (% of holdings)
Camargue	1400	43	93	84	50	43
Plaine et Val de Sèvre	500	73	85	55	8	84
Armorique	4000	97	46	36	10	90
Gascony Valleys and Hills	400	61	51	43	19	68

discussed through local management agencies and local public policies. Considering the inter-regional heterogeneity of agricultural landscapes and biodiversity issues, the intra-regional heterogeneity of farmers (Celio et al. 2014), and the social and contextual nature of SRs (Halfacree 1993), we hypothesize (H2) that the local environment is likely to influence SRs of the landscape. Depending on the area, issues related to the agricultural landscapes can certainly be more or less important in the local social arena and thus trigger differently the different processes through which social representations of an object appear. Consequently, the SR of the agricultural landscape is more or less likely to show a high structuration degree depending on the local context. Thus, we made a second prediction: (P2) some words belonging to the core of the SR will be cited in common by farmers regardless of the site they farm on while the peripheries of the SRs will differ among sites. We expected a decrease in saliency of functional words related to specific practices or precise descriptions when territorial coordination decreases.

Studied SESs

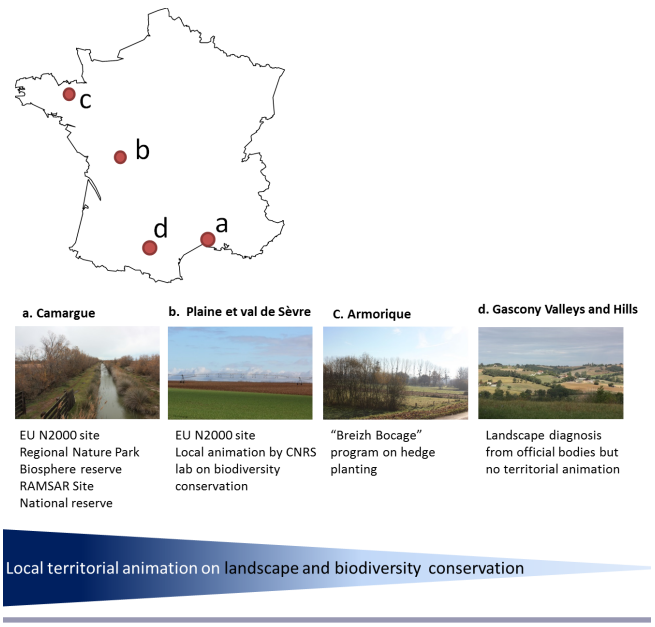
Our study took place in four French SESs studied in the FarmLand BiodiVERsA project (https://www.farmland-biodiversity.org/index.php?sujet=1&lang=en): Gascony Valleys and Hills, Armorique, Plaine et Val de Sèvre, and the Camargue (Fig. 2 and Appendix 2). The project aimed at assessing the relationships among landscape heterogeneity, biodiversity, and ecosystem services to provide orientations for more efficient agricultural policies on the landscape scale[1] (Sirami et al. 2019).

In the past 50 years, the four SESs have known agricultural intensification and specialization that has led to a decrease in the number of cultivated crops and of holdings, and to an increase in sizes of fields and farms and consequent decrease in hedges, though these processes varied qualitatively and quantitatively between SESs. However, the degree to which issues related to the local landscape, e.g., restoring the hedgerows network for conserving farmland biodiversity, are the subject of local public policies or locally advocated by various stakeholders varied among SESs (Fig. 2 and Appendix 2). These differences induce differences among SESs in the local dispersal of information or pressure to infer on the social group of farmers. Table 2 provides the main features of each SES and a more detailed description of each context is provided in Appendix 2.

Sampling of farmers

Our sampling design aimed to encompass the local diversity of landscape conditions and farm types in each SES rather than selecting a statistically representative sample of farmers. Within each studied SES, sampling areas were selected along a gradient of landscape heterogeneity (Calatayud et al. 2012, Pasher et al. 2013). We contacted farmers to obtain a sample of 30 farmers per SES located along a large gradient of landscape heterogeneity, i.e., considering the land cover and the biodiversity conservation perimeters of each site, and covering the local range of farming systems. Sample characteristics for each SES are provided in Appendix 2, Table A2.1. The size of the sample (119 farmers distributed across four SESs) was constrained by our interview design and resulted from a trade-off between total time allowed to the study and number of selected SESs on which to conduct our comparative analysis. As highlighted in the introduction, this specific work took place in a Biodiversa project where we elicited and analyzed individual mental models (IMM) of farmers and their relationships to land management practices (Vuillot 2015, Vuillot et al. 2016). The free listing was done during the first 15 min of an in-depth 2-hour, face-to-face interview aiming to elicit the IMM.

Fig. 2. The four French study sites.



Survey

All interviews were conducted on the farms or in the homes of the farmers. In contrast to many studies on landscape perceptions and preferences, we chose not to conduct the interviews outside

Table 3. Thematic categories analysis results: Farmers' social representation of the inductor item "landscape" based on study sites (frequency). The number in parentheses indicates how frequently the induced word was associated with the inductor. Categories followed by † are "consensual" categories according to the binomial test.

		Camargue (n = 30)		Plaine et Val de Sèvre (n = 30)	
		First rankings	Later rankings	First rankings	Later rankings
Frequency	High	wild nature, biodiversity (14)† topography (13)† wetlands (9) water (8) livestock farming (7) crop types (7) view sight skyline (6) places, areas (6)	aesthetics (5) territorial identity, culture, tradition (5)	topography (18)† trees, hedgerows (17)† aesthetics (6) crop types (6) agriculture (5)	water (8)† wetlands (6) lack of (5)
	Low	landscape (4) diversity, contrasts (4) human activity (4) lived-in landscape (3)	agriculture (4) trees, hedgerows (4) lack of (4) pattern, layout (3) environment (3) climate, seasons (3) soil, earth (3)	view sight skyline (3) diversity, contrasts (3) places, areas (3)	Woods, forests (4) soil, earth (3) access, travel (3) evaluative judgement (3) pattern, layout (3)
		Armorique (n = 30)		Gascony Valleys and Hills (n = 29)	
		First rankings	Later rankings	First rankings	Later rankings
Frequency	High	agriculture (14)† trees, hedgerows (13)† woods, forests (13)† topography (8) pattern, layout (6) diversity, contrasts (5)	Planning, maintenance (9)† aesthetics (5) wild nature, biodiversity (5) evaluative judgement (5) livestock farming (3)	topography (19)† diversity, contrasts (7) aesthetics (6) grass, meadows (6) territorial identity, culture, tradition (6)	agriculture (7) livestock farming (6) woods, forests (5)
	Low	countryside(4) territorial identity, culture, tradition (3) evolution (3) water (3)	Profession, agricultural practices (4) lived-in landscape (4) lack of (3) altered deteriorated (3) places, areas (3) grass, meadows (3) crop types (3)	trees, hedgerows (4)	landscape (4) lived-in landscape (4) water (4) crop types (4)) wild nature, biodiversity (3) patter, layout (3) profession, agricultural practices (3)

Categories cited by less than 10% of farmers within a given study site are not presented in this table.

in order to access the farmers' abstract cognitive representation of the landscape, i.e., what they spontaneously associated with the concepts, rather than their perception of a given scenery. It was explained to respondents that the aim of the study was to learn about their own vision of the local landscape as farmers working there. No photographs were shown; the European Landscape Convention definition of the landscape was given to each respondent and the SES boundaries were indicated beforehand on a map showing only waterways and main cities.

Farmers were asked to complete two free association tasks in a row, referring to the term "landscape" (*paysage*) and then "agricultural landscape" (*paysage agricole*) as inductor items. The inductor item "landscape" was always given before "agricultural landscape." This design aimed at disentangling what was specific to the representation of the agricultural landscape, assuming that the representation of the "agricultural landscape" was likely to be partly anchored in the representation of the "landscape" (Doise 1985, 1992, Jeziorski and Ludwig-Legardez 2013). We chose a multiple response free association technique: respondents were asked to utter spontaneously the first words that came to mind when hearing the inductor items with no restriction on the number of words uttered (Flament and Rouquette 2003). The same person (CV) conducted all the interviews. In compliance with French law, we did not collect any personal data.

Analyses

We analyzed words uttered in each site using the second option of the methodological approach previously described. We first performed a prototypical analysis followed by a categorical analysis. The categorization process was performed by CV and crosschecked by RM on a random sample of words. The details of the categorization grid is provided in Appendix 1. All analyses were performed with R (R Core Team 2014) and the R script we wrote can be found in Appendix 1.

RESULTS

We present below our comparative analysis of farmers' SRs of the agricultural landscape in our four contrasted SESs. Results regarding our first prediction on the consensus level and variability of the representation are based on the prototypical analyses. Results regarding our second prediction on the content of social representations are based on our categorical analysis; details about the prototypical results can be found in Appendix 3. The results of the free association task with the inductor item "landscape" are displayed in Table 3 and results with the inductor item "agricultural landscape" are displayed in Table 4. Comparing these two inductor items allows for evaluating to what degree the SR of the "agricultural landscape" is embedded in the SR of the "landscape." In the resulting tables, consensual words are identified with the symbol † (Table 3 and Table 4).

Table 4. Thematic categories analysis results: Farmers' social representation of the inductor item "agricultural landscape" based on study sites (frequency). The first number in parentheses indicates how frequently the induced word was associated with the inductor. Categories followed by † are "consensual" categories.

	Camargue (n = 30)		Plaine et Val de Sèvre (n = 30)	
Frequency	First rankings	Later rankings	First rankings	Later rankings
High	crop types (17)† livestock farming (8)† pattern, layout (7) evaluative judgement (6) agriculture (5)	water management (9)† topography (5)	crop types (14)† pattern, layout (13)† agriculture (11)† topography (9)† diversity, contrasts (7) profession, agricultural practices (7) trees, hedgerows (6)	livestock farming (5)
Low	soil, earth (3)	planning, maintenance (4) water (4) human activity (3) environment (3) territorial identity, culture, tradition (3) view sight skyline (3)	evolution (4) aesthetics (3) evaluative judgement (3)	planning, maintenance (4) water management (4) grass, meadows (4) territorial identity, culture, tradition (4) lack of (3) places, areas (3) lived-in landscape (3)
	Armorique (n = 30)		Gascony Valleys and Hills (n = 29)	
Frequency	First rankings	Later rankings	First rankings	Later rankings
High	agriculture (14)† pattern, layout (12 lived-in landscape (10)† lack of (6) evaluative judgement (6)	planning, maintenance (12)† livestock farming (12)† trees, hedgerows (6) extensive (6) grass, meadows (6)	livestock farming (16)† agriculture (15)† topography (10)† grass, meadows (9)† diversity, contrasts (8)	woods, forests (11)† evaluative judgement (7)
Low	woods, forests (5) countryside(5) diversity, contrasts (5) human activity (3) farmers, peasants/countrymen (3) evolution (3) topography (3)	crop types (5) wild nature, biodiversity (4) altered deteriorated (3) aesthetics (3) agricultural production (3) villages, built environment (3)	lived-in landscape (4) pattern, layout (4) crop types (4) profession, agricultural practices (3)	trees, hedgerows (5) wild nature, biodiversity (4) farmers, peasants/countrymen (3)

Categories cited by less than 10% of farmers within a given study site are not shown in this table.

Intra-SES consensus and variability analysis (P1)

Our results showed a weak intra-SES consensus for all SESs and both inductor items. The proportion of consensual words among all uttered words ranged from 2.0% to 4.2% (Table 5). Consensus levels did not differ significantly between SESs (Fisher's exact test, $p > 0.1$). The proportion of hapax, indicating intra-group variability was high in all SESs and for both free-listing tasks. It ranged from 65% to 79% (Table 5). We found no significant differences between SESs regarding intra-SES variability. To sum up, consensus and intra-group variability did not significantly differ between SESs; this does not allow us to validate our first prediction.

Qualitatively, it can be observed, though, that in Camargue and Armorique, where landscape issues are more publicized and discussed in social arenas, the consensus is higher on words associated with the inductor "landscape" than with "agricultural landscape" whereas in Gascony Valleys and Hills and Plaine et Val de Sèvre, the consensus is higher on "agricultural landscape" (Table 5). Camargue is the SES with the lowest number of hapax to describe "landscape" whereas Gascony Valleys is the SES with the lowest number of hapax associated to the "agricultural landscape" (Table 5).

Comparing the central cores and the peripheries between SESs (P2)

Through the categorical analysis of the social representation of the "landscape" (Table 3) we found that the unique category in common at the central core of the representation in the four different SESs was related to the topographical features of the landscape. Then, seminatural elements (hedges, meadows, or woods) can be found in the central core in all SESs but the Camargue, where natural elements are more salient (wild nature, wetlands). It can be further noted that within the central core, topography is perceived as the most salient element in Gascony Valleys and Hills and Plaine et Val de Sèvre, i.e., the SESs where landscape issues are less publicized and discussed in social arenas (see Fig. 2). By contrast, in Armorique, issues related to agriculture and to seminatural elements (hedges and woods) are the most salient and in Camargue issues related to wild nature and biodiversity are the most salient.

The categorical analysis of the social representation of the "agricultural landscape" (Table 4) also showed very few elements in common in the central core of the representation in the four SESs. The unique category we found in common is made of words related to the agricultural vocation of the landscape. Then, the category referring to the patterns created by agriculture on the

Table 5. Proportion of hapax and words consensually associated by farmers with the terms "landscape" and "agricultural landscape." A word is "consensual" when it has been cited more frequently than the binomial threshold (see Methods). A hapax is a word uttered by only one respondent in a given site. The Fisher's exact test was used to compare the proportions of consensual words and hapax between sites.

		Camargue	Plaine et Val de Sèvre	Armorique	Gascony Valleys and Hills	Fisher's Exact Test p-value
	No. of farmers =	30	30	30	29	
Landscape	Total number of words uttered	96	97	123	104	
	Proportion of consensual words	4.20%	3.10%	2.40%	2.90%	1
	Proportion of hapax	64.60%	75.30%	71.50%	73.10%	0.3895
Agricultural Landscape	Total number of words uttered	111	113	151	95	
	Proportion of consensual words	3.60%	3.50%	2.00%	4.20%	1
	Proportion of hapax	78.40%	76.10%	79.50%	71;60%	0.5233

landscape, e.g., plots size or plot plans, is present in the central core in all sites except Gascony Valleys and Hills.

Beside these inter-SESs consensual elements, many differences can be observed at the central core and on the peripheries of the social representation among the four SESs. We observe that, if part of the content (type of categories) of the representation is shared among SESs, the structure (the place of these categories within the representation) varies a lot. It is beyond the scope of this illustrative case study to detail here all the fine differences among SESs, but we invite interested readers to refer to Tables 3 and 4 as well as Appendix 3 for an exhaustive view of results. The results highlighted above seem to confirm our second prediction, that some elements would be found in common in the core of the SRs regardless of the SES while the peripheries would differ among SESs, although we found fewer similarities between the four central cores than expected.

The categorical analysis showed also that in Camargue, the category "wild nature and biodiversity" is a core element in the representation of the "landscape" (Table 3) but is not part of the representation of the "agricultural landscape" at all (Table 4). In Plaine et Val de Sèvre, the category is absent from both representations. In Armorique and Gascony Valleys and Hills, "wild nature and biodiversity items" lay at the periphery of both "landscape" and "agricultural landscape" representations. These results show that the representation of the "landscape" was most inclusive of nondomestic nature in Camargue, where many conservation tools are applied on the territory, but the SR of the "agricultural landscape" excluded it. Surprisingly, nondomestic nature is absent from representation in Plaine et Val de Sèvre despite a high level of territorial animation on conservation issues through Natura 2000 and Agro-Environmental Scheme (AES) contracts.

DISCUSSION

Here, we revisit our two sets of hypothesis/prediction in light of our results and highlight possible consequences for agricultural landscape management and biodiversity conservation policies. We also discuss the benefits of our methodological approach.

Discussion on consensus and intra-group variability levels (H1/P1)

Our first hypothesis (H1) was that the level of local public policies dealing with agricultural landscape had an impact on the content and structure of the social representation. Our first prediction (P1) was that we should find a greater proportion of consensual words and smaller proportion of hapax in study sites where landscape issues are advertised and discussed through local management agencies and local public policies.

In all study sites, farmers' SRs of the landscape and of the agricultural landscape seemed poorly structured because consensus level was low and hapax proportion was high. We found no significant differences in consensus between sites. This would suggest that the "landscape" and "agricultural landscape" are not exactly social objects yet for the social group of "farmers"; the representations are still emerging (Jeziorski 2014). Indeed, according to Moscovici (1976), an SR cannot appear without sufficient "focalization" and "pressure to infer" processes. This means that members of the social group have to be sufficiently exposed to a social object and sufficiently pressured by the social context for them to position themselves on the object as a social group and elaborate a social representation of the object. Both processes might not have been strong enough in our study sites, even in Camargue, despite policy makers' growing interest in the landscape.

We found that the SR of "landscape" is more structured than the representation of the "agricultural landscape" in Camargue and Armorique, whereas in Gascony and Plaine et Val de Sèvre, consensus is higher on "agricultural landscape." This could indicate stronger processes of "dispersal of information," "focalization," and "pressure to infer" on the social subject of the "landscape" in Armorique and Camargue. This could be due to, respectively, high visibility of the decrease in the hedgerow density for its impact on landscape aesthetic and tourism in Armorique (Bazin and Schmutz 1994, Burel and Baudry 1995, Perichon 2004, 2005, Thenail and Baudry 2004) and an important communication effort on the remarkable features of the Camargue landscape by the Regional Nature Park (Mathevet 2004). In PVDS and Gascony, the agricultural vocation of those

territories might be more anchored so that there are fewer issues about the "landscape," its aesthetic, "focalization" being mainly on agricultural issues. In addition, we found few collectively shared items across regions even through the categorical analysis suggested very local and social representations of the "landscape" and the "agricultural landscape."

Regarding the implication for public policies, weak consensus and great variability of representations is likely to be an obstacle to any landscape management public policy. The local land management agency still has to build a shared representation of the landscape with farmers before designing or implementing any policy. Moreover, the very few similarities between regions favor a territorialized approach (context-specific approach) for landscape management policies. Consequently, the first step would be to locally raise the landscape as a concern for farmers, for example, through collective building of a shared representation to design innovative policies (Berthet et al. 2016, De Vreesse et al. 2019) aimed at improving farmers' stewardship of the landscape (Scherr and McNeely 2007, de Sainte Marie 2014).

A core of SRs dominated by physical and descriptive dimensions (H2/P2)

Our second hypothesis (H2) was that the local environment is likely to influence SRs of the landscape. Our second prediction (P2) was that some words belonging to the core of the SR will be cited in common by farmers regardless of the site they farm on while the peripheries of the SRs will differ among sites.

Farmers SRs of the "landscape" and the "agricultural landscape" were mainly descriptive and aesthetic at the core, and descriptive, aesthetic, and functional (Buijs et al. 2011) on the periphery. This result seems to be in line with similar studies conducted in different cultural contexts such as Malta (Conrad et al. 2011). Indeed, several studies have shown that the landscape experience is mostly a process of social and cultural mediation (Berque 1995). In addition to its physical dimensions, landscape is a sensitive and emotional experience linked both to its physical shape and to cultural and social norms. That means that the landscape is not only facts or emotions: it is both ontological and ideological (Matless 2003).

We found that SRs of the "landscape" may be more linked to the sensitive interpretation, revealing the main symbolic and cultural norms of the region, whereas SRs of the "agricultural landscape" may be structured more by the practical dimensions of farming, as Baumgart-Getz et al. (2012) showed in their literature review. Information, financial and networking variables better explain why farmers adopt best management practice in the USA. It thus appears that the restriction of the "landscape" through the addition of the adjective "agricultural" leads to changes in several dimensions of the SR: the aesthetic dimension ("scenery" dimension) becomes less important and the functional dimensions are more salient, the emphasis on seminatural component decreases and emphasis on cropped or grazed areas increases. This result is consistent with Rateau (1998) and Gruev-Vintila and Rouquette (2007), which suggested that the descriptive and functional dimensions are dominant in the SRs of an object when individuals practice with this object.

Consequently, we recommend that landscape management policies focus on the "agricultural landscape" as being a coproduction of farming activities and natural features (Gibon 2005), with which farmers can more easily identify, and feel in charge. However, our results suggest that SRs of the "agricultural landscape" show a weak consensus due to poor focalization on this subject in each region. This suggests that research and conservation processes, such as applied sciences, collaborative sciences, or action-researches that have occurred in these regions did not seem to have triggered a higher structuration degree, i.e., consensus level, of the SR. The "agricultural landscape," and a fortiori the "landscape," is still the subject of a negotiation process and needs to be collectively discussed before any new conservation or adaptive management policy is elaborated (Mathevet et al. 2014).

Critical discussion on results produced and SRT

Our results suggest that SRs of the "landscape" tend to be overlooked in the existing governance processes of these territories, i.e., weak consensus and great variability of SRs is likely to be an obstacle to any landscape management public policy. The local land management agencies of several SESs still have to shape a shared representation of the "landscape" with farmers in order to implement an efficient policy. This seems problematic because these context-specific SRs could motivate stakeholders to participate in the planning process (De Vresse et al. 2019). We think that we need to change our own ways of thinking about agricultural policy design by developing more bottom-up processes that would frame and integrate farmers' SRs (Mathevet et al. 2014, Vuillot et al. 2016). Understanding shared and unshared elements is a means to increase mutual comprehension, to create an arena for deliberation on SES's management and planning, and to frame solutions that deal with divergent visions (Plieninger et al. 2015, Raymond et al. 2014, Mathevet et al. 2018*a*) and that build landscape stewardship (Bieling and Plieninger 2017). In addition to the SRT, concepts like place attachment (Brown et al. 2019) and ecological solidarity (Mathevet et al. 2016) could help understanding SRs and implementing a sound social-ecological stewardship (Mathevet et al. 2018*b*, Chapin et al. 2009).

Our previous work on individual mental models suggested that farmers' ways of thinking and ways of farming were linked (Vuillot et al. 2016) but also that farming practices under strong policy and technical or economic constraints, influence farmers' representations (see also Baumgart-Getz et al. 2012). Thus, building shared representations by increasing farmers' awareness of social-ecological interdependencies may not be sufficient to change practices or to promote any new landscape management policy because technological and economic path-dependency processes continue to shape the acceptance on the grounds of any biodiversity friendly landscape recommendations (Pe'er et al. 2014, Sirami et al. 2019). Although SRs do not suffice to explain practices, they provide a better understanding of how contexts, institutional, and organizational dimensions guide, if not determine, practices. It was not the purpose of this study to report on the interview findings outside of free-listing activities, but it is obvious that measuring SRs should be articulated with broader observations that more fully explain how SRs are socially constructed, i.e., in our case study, SRs are elaborated and are fundamentally part of social interactions that were mainly characterized in each SES by the intensity of local territorial animation on landscape and biodiversity conservation (see Fig. 2 and Appendix 3). An interdisciplinary method coupling SRs'

elicitation, interviews, mental models, and farming systems approaches provides an opportunity to enhance our understanding of the relationships between farmers' worldviews and their practices, in order to design better biodiversity conservation policies in farmed landscapes (Vuillot 2015).

Finally, SRs are embedded in dialogue and debate processes, media, and scientific discourses (Moscovici and Marková 2000, Höjier 2011). Thus SRs are also shaped by power relations (Vorlklein and Howarth 2005). Various representations of the same social objects, here the landscape, are operated to achieve different ends (Howarth 2006). Different social groups or stakeholders/individuals have different levels of access to the construction of the social reality of any SES processes within the public arena, and thus to the legitimization of knowledge systems; they, therefore, experience different levels of social marginalization or inclusion processes (Voelklein and Howarth 2005). SRs are dynamic systems of knowledge, they are always open to negotiation (Howarth et al. 2014), and powerful groups can shape social reality by actively participating in the construction of SRs, i.e., political participation being defined as "the power to construct and convey particular representations over others" by Howarth et al. (2014:21). As these authors stated, hegemonic representations could be normative and shape ways of thinking and engaging with others (Moloney and Walker 2002). In our case studies, we observed that no SR of any SES is dominated by a hegemonic vision of nature conservation nor intensive farming worldviews. Different knowledge systems compete for the social construction of meaning, i.e., nature conservation, intensive farming, organic farming, traditional, hedonistic, economic worldviews (Mathevet 2004, Vuillot et al. 2016). Thus, how knowledge is legitimized and reified is an important research area. The SRT, despite some theoretical criticism, may provide ways to critically analyze the SES management and landscape planning. By allowing rigorous data collection and comparative analysis process, the method we have provided and this type of analysis could facilitate the study of the social-ecological consequences of SRs and the relationship between SRs, power relations, and social conflicts.

CONCLUSION

In this paper, we highlighted the value of studying SRs and proposed a methodological approach to elicit SRs and compare them in a standardized and efficient way. We applied this approach to the study of SRs of the "landscape" and the "agricultural landscape" among distinct social-ecological contexts. Our case study demonstrated how this standardized approach allowed us to detect subtle differences both among social-ecological contexts and objects. Moreover, we showed that this approach can be used to compare SRs across studies with various sample sizes and various consensus levels. This type of comparison, among social groups or localities, is crucial to understand processes that influence the content and structuration level of SRs. Our methodological approach represents a trade-off between reliability and feasibility, especially for nonspecialists, because it is easy to implement and allows comparisons between space, time, social groups, and subjects of representation, provided a unified methodological approach is adopted. We therefore hope that this method will convince more people to use the SRT in SES studies. This method should also facilitate meta-analysis across various studies on SRs of SESs, which will contribute to a better understanding of the dynamics of SRs in space and time, and their contribution to adaptive management of SES (Lai et al. 2016, Bouamrane et al. 2017).

Responses to this article can be read online at:
http://www.ecologyandsociety.org/issues/responses.php/11636

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Data Availability Statement:

The data/code that support the findings of this study are available on request from the corresponding author, RM.

LITERATURE CITED

Abric, J.-C. 1989. L'étude expérimentale des représentations sociales. Pages 187-203 *in* D. Jodelet, editor. *Les représentations sociales*. Presses Universitaires de France, Paris, France.

Abric, J.-C. 1994. L'organisation interne des représentations sociales: système central et système périphérique. Pages 73-84 *in* C. Guimelli, editor. *Structures et transformation des représentations sociales*. Delachaux et Niestlé, Neuchâtel, Switzerland.

Abric, J.-C. 2001*a*. Pratiques sociales, représentations sociales. Pages 217-238 *in* J. C. Abric, editor. *Pratiques sociales et représentations*. Presses Universitaires de France, Paris, France.

Abric, J.-C. 2001*b*. A structural approach to social representations. Pages 42-47 *in* K. Deaux and G. Philogène, editors. *Representations of the social: bridging theoretical traditions*. Blackwell, Oxford, UK.

Abric, J.-C. 2003. L'analyse structurale des représentations sociales. Pages 375-392 *in* S. Moscovici and F. Buschini, editors. *Les méthodes des sciences humaines*. Presses Universitaires de France, Paris, France.

Abric, J.-C. 2011. *Pratiques sociales et représentations*. Presses Universitaires de France, Paris, France.

Agreste. 2000. *Recensement Agricole – 2000. Actualité et statistique agricole.* Agreste, Paris, France. [online] URL: http://37.235.92.116/enquetes/structure-des-exploitations-964/recensement-agricole-2000/

Alessio, R. L. D. S., T. Apostolidis, M. de Fátima de S Santos, and L. Dany. 2011. Représentations sociales et embryon humain:

une étude comparative Brésil/France. *Cahiers Internationaux de Psychologie Sociale* 92:371-395. https://doi.org/10.3917/cips.092.0371

Anderson, N. M., R. M. Ford, and K. J. H. Williams. 2017. Contested beliefs about land-use are associated with divergent representations of a rural landscape as place. *Landscape and Urban Planning* 157:75-89. https://doi.org/10.1016/j.landurbplan.2016.05.020

Anderson, N. M., K. J. H. Williams, and R. M. Ford. 2013. Community perceptions of plantation forestry: the association between place meanings and social representations of a contentious rural land use. *Journal of Environmental Psychology* 34:121-136. https://doi.org/10.1016/j.jenvp.2013.02.001

Audouit, C., V. Pasqualini, R. De Wit, H. Flanquart, P. Deboudt, and C. Rufin-Soler. 2019. Comparing social representation of water quality in coastal lagoons with normative use of ecological indicators. *Marine Policy* 101:137-146. https://doi.org/10.1016/j.marpol.2017.08.023

Barreteau, O., D. Giband, M. Schoon, J. Cerceau, F. DeClerck, S. Ghiotti, T. James, V. A. Masterson, R. Mathevet, S. Rode, F. Ricci, and C. Therville. 2016. Bringing together social-ecological system and *territoire* concepts to explore nature-society dynamics. *Ecology and Society* 21(4):42. https://doi.org/10.5751/ES-08834-210442

Barsalou, L. W. 2009. Simulation, situated conceptualization, and prediction. *Philosophical Transactions of the Royal Society B: Biological Sciences* 364:1281-1289. https://doi.org/10.1098/rstb.2008.0319

Baumgart-Getz, A., L. Stalker Prokopy, and K. Floress. 2012. Why farmers adopt best management practice in the United States: a meta-analysis of the adoption literature. *Journal of Environmental Management* 96(1):17-25. https://doi.org/10.1016/j.jenvman.2011.10.006

Bazin, P., and T. Schmutz. 1994. The rise and fall of hedgerow landscaping in Europe. *Revue Forestière Française* 46:115-118.

Bergamaschi, A. 2011. Attitudes et représentations sociales. *Revue Européenne des Sciences Sociales* 49(2):93-122. https://doi.org/10.4000/ress.996

Berque, A. 1995. *Les raisons du paysage: de la Chine antique aux environnements de synthèse*. Fernand Hazan, Paris, France.

Berthet, E. T. A., C. Barnaud, N. Girard, J. Labatut, and G. Martin. 2016. How to foster agroecological innovations? A comparison of participatory design methods. *Journal of Environmental Planning and Management* 59(2):280-301. https://doi.org/10.1080/09640568.2015.1009627

Bieling, C., and T. Plieninger. 2017. *The science and practice of landscape stewardship*. Cambridge University Press, Cambridge, UK. https://doi.org/10.1017/9781316499016

Blicharska, M., and A. Van Herzele. 2015. What a forest? Whose forest? Struggles over concepts and meanings in the debate about the conservation of the Białowieza Forest in Poland. *Forest Policy and Economics* 57:22-30. https://doi.org/10.1016/j.forpol.2015.04.003

Bouamrane, M., R. Mathevet, H. Levrel, H. Huntington, and A. Agrawal. 2017. Community participation and adaptation to change in biosphere reserves: a review and a Mediterranean European coastal wetland case study (Rhone Delta Biosphere Reserve, Southern France). Pages 120-138 *in* D. Armitage, A. Charles, and F. Berkes, editors. *Governing the coastal commons: communities, resilience and transformation*. Routledge, New York, New York, USA. https://doi.org/10.4324/9781315688480-7

Brown, K., W. N. Adger, P. Devine-Wright, J. M. Anderies, S. Barr, F. Bousquet, C. Butler, L. Evans, N. Marshall, and T. Quinn. 2019. Empathy, place and identity interactions for sustainability. *Global Environmental Change* 56:11-17. https://doi.org/10.1016/j.gloenvcha.2019.03.003

Buijs, A. E., B. J. M. Arts, B. H. M. Elands, and J. Lengkeek. 2011. Beyond environmental frames: the social representation and cultural resonance of nature in conflicts over a Dutch woodland. *Geoforum* 42:329-341. https://doi.org/10.1016/j.geoforum.2010.12.008

Buijs, A. E., B. Pedroli, and Y. Luginbühl. 2006. From hiking through farmland to farming in a leisure landscape: changing social perceptions of the European landscape. *Landscape Ecology* 21:375-389. https://doi.org/10.1007/s10980-005-5223-2

Burel, F., and J. Baudry. 1995. Social, aesthetic and ecological aspects of hedgerows in rural landscapes as a framework for greenways. *Landscape and Urban Planning* 33:327-340. https://doi.org/10.1016/0169-2046(94)02026-C

Calatayud, F., S. Ladet, G. Balent, and L. Fahrig. 2012. A mapping method of crop composition and configuration to study their effect on biodiversity of European agricultural landscapes. Pages 308-311 *in* J. Gensel, D. Josselin, and D. Vandenbroucke, editors. *Proceedings of the AGILE'2012 International Conference on Geographic Information Science. Presented at the Multidisciplinary Research on Geographical Information in Europe and Beyond*, Avignon, France.

Celio, E., C. G. Flint, P. Schoch, and A. Grêt-Regamey. 2014. Farmers' perception of their decision-making in relation to policy schemes: a comparison of case studies from Switzerland and the United States. *Land Use Policy* 41:163-171. https://doi.org/10.1016/j.landusepol.2014.04.005

Chapin III, F. S., G. P. Kofinas, and C. Folke. 2009. *Principles of ecosystem stewardship. Resilience-based natural resource management in a changing world*. Springer, New York, New York, USA. https://doi.org/10.1007/978-0-387-73033-2

Conrad, E., M. Christie, and I. Fazey. 2011. Understanding public perceptions of landscape: a case study from Gozo, Malta. *Applied Geography* 31:159-170. https://doi.org/10.1016/j.apgeog.2010.03.009

Dany, L., I. Urdapilleta, and G. L. Monaco. 2015. Free associations and social representations: some reflections on rank-frequency and importance-frequency methods. *Quality & Quantity* 49:489-507. https://doi.org/10.1007/s11135-014-0005-z

de Sainte Marie, C. 2014. Rethinking agri-environmental schemes. A result-oriented approach to the management of species-rich grasslands in France. *Journal of Environmental Planning and Management* 57:704-719. https://doi.org/10.1080/09640568.2013.763772

De Vreese, R., A. V. Herzele, N. Dendoncker, C. M. Fontaine, and M. Leys. 2019. Are stakeholders' social representations of nature and landscape compatible with the ecosystem service concept?

Ecosystem Services 37:100911. https://doi.org/10.1016/j.ecoser.2019.100911

Deconchy, J.-P. 2003 (1984). Croyances et idéologies. Pages 331-355 *in* S. Moscovici, editor. *Psychologie sociale.* Quadrige, Presses Universitaires de France, Paris, France.

Doise, W. 1985. Les représentations sociales: définition d'un concept. *Connexions* 45:243-253.

Doise, W. 1992. L'ancrage dans les études sur les représentations sociales. *Bulletin de Psychologie* 45:189-195.

Doise, W., A. Clemence, and F. Lorenzi-Cioldi. 1993. *The quantitative analysis of social representations*. Harvester Wheatsheaf, London, UK.

Durkheim, E. 1968 (1912). *Les formes élémentaires de la vie religieuse.* Presses Universitaires de France, Paris, France.

Elands, B. H. M., and K. F. Wiersum. 2001. Forestry and rural development in Europe: an exploration of socio-political discourses. *Forest Policy and Economics* 3:5-16. https://doi.org/10.1016/S1389-9341(00)00027-7

European Council. 2000. *European landscape convention*. Council of Europe, Strasbourg, France.

Farr, R. M. 1991. Les représentations sociales: la théorie et ses critiques. *Bulletin de Psychologie* 45:183-188.

Farr, M. R. 2003 (1984). Les représentations sociales. Pages 379-389 *in* S. Moscovici, editor. *Psychologie sociale.* Quadrige, Presses Universitaires de France, Paris, France.

Flament, C., and M.-L. Rouquette. 2003. *Anatomie des idées ordinaires: comment étudier les représentations sociales*. Armand Colin, Paris, France.

Galand, C., and E. Salès-Wuillemin. 2009. La représentation des drogues chez les étudiants en psychologie: effets des pratiques de consommation et influence de l'entourage. *Les Cahiers Internationaux de Pyschologie Sociale* 84:125-152. https://doi.org/10.3917/cips.084.0125

Gibon, A. 2005. Managing grassland for production, the environment and the landscape. Challenges at the farm and the landscape level. *Livestock Production Science* 96:11-31. https://doi.org/10.1016/j.livprodsci.2005.05.009

Gilg, A. 2009. Perceptions about land use. *Land Use Policy* 26: S76-S82. https://doi.org/10.1016/j.landusepol.2009.08.018

Gruev-Vintila, A., and M. L. Rouquette. 2007. Social thinking about collective risk: how do risk-related practice and personal involvement impact its social representations? *Journal of Risk Research* 10:555-581. https://doi.org/10.1080/13669870701338064

Guimelli, C., and M.-L. Rouquette. 1992. Contribution du modèle associatif des schèmes cognitifs de base à l'analyse structurale des représentations sociales. *Bulletin de Psychologie* 405:196-202.

Halfacree, K. H. 1993. Locality and social representation: space, discourse and alternative definitions of the rural. *Journal of Rural Studies* 9:23-37. https://doi.org/10.1016/0743-0167(93)90003-3

Herzlich, C. 1972. La représentation sociale. Pages 303-325 *in* S. Moscovici, editor. *Introduction à la psychologie sociale*. Larousse, Paris, France.

Höijer, B. 2011. Social representations theory. A new theory for media research. *Nordicom Review* 32(2):3-16. https://doi.org/10.1515/nor-2017-0109

Holm, S. 1979. A simple sequentially rejective multiple test procedure. *Scandinavian Journal of Statistics* 6(2):65-70.

Howarth, C. 2006. A social representation is not a quiet thing: exploring the critical potential of social representations theory. *British Journal of Social Psychology* 45:65-86. https://doi.org/10.1348/014466605X43777

Howarth, C., E. Andreouli, and S. Kesi. 2014. Social representations and the politics of participation. Pages 19-38 *in* P. Nesbitt-Larking, C. Kinnvall, T. Capelos, and H. Dekker, editors. *The Palgrave handbook of global political psychology*. Palgrave Macmillan, London, UK. https://doi.org/10.1007/978--1-137-29118-9_2

Jeziorski, A. 2014. *Étude des représentations sociales du développement durable dans une perspective didactique: une contribution à la formation des enseignants à l'éducation au développement durable (thèse en didactique)*. Université Laval Québec, Canada et Aix-Marseille Université, Marseille, France.

Jeziorski, A., and A. Ludwig-Legardez. 2013. Éducation au développement durable: la difficulté de concevoir une action éducative interdisciplinaire. *Revue Francophone du Développement Durable* 1:30-59.

Jodelet, D. 1989. *Folies et représentations sociales*. Presses Universitaires de France, Paris, France.

Jodelet, D. 1991. L'idéologie dans l'étude des représentations sociales. Pages 15-33 *in* V. Aebischer, J.-P. Deconchy, and E. M. Lipianski, editors. *Idéologies et représentations sociales*. Les Éditions Delval, Cousset, Switzerland.

Jodelet, D. 2003 (1994). *Les représentations sociales*. Presses Universitaires de France, Paris, France.

Jones, N. A., H. Ross, T. Lynam, P. Perez, and A. Leitch. 2011. Mental models: an interdisciplinary synthesis of theory and methods. *Ecology and Society* 16(1):46. https://doi.org/10.5751/ES-03802-160146

Krien, N., and É. Michel-Guillou. 2014. Place des risques côtiers dans les représentations sociales du cadre de vie d'habitants de communes littorales. *Les Cahiers Internationaux de Psychologie Sociale* 101(1):101-122. https://doi.org/10.3917/cips.101.0101

Lai, P.-H., Y.-C. Hsu, and S. Wearing. 2016. A social representation approach to facilitating adaptive co-management in mountain destinations managed for conservation and recreation. *Journal of Sustainable Tourism* 24(2):227-244. https://doi.org/10.1080/09669582.2015.1062018

Lebart, L., and A. Salem. 1988. *Analyse statistique des données textuelles*. Dunod. Paris. France.

Lemée, C., M. Guillard, G. Fleury-Bahi, N. Krien, C. Chadenas, E. Chauveau, M. Desse, M. Coquet, M. Lamarre, and O. Navarro. 2019. What meaning do individuals give to coastal risks?

Contribution of the social representation theory. *Marine Policy* 108:103629. https://doi.org/10.1016/j.marpol.2019.103629

Lo Monaco, G., A. Piermattéo, P. Rateau, and J. L. Tavani. 2017. Methods for studying the structure of social representations: a critical review and agenda for future research. *Journal for the Theory of Social Behaviour* 47:306-331. https://doi.org/10.1111/jtsb.12124

Luginbühl, Y., P. Howard, and D. Terrasson, editors. 2015. *Landscape and sustainable development: the French perspective*. Routledge, London, UK. https://doi.org/10.4324/9781315591360

Lynam, T., and K. Brown. 2011. Mental models in human-environment interactions: theory, policy implications, and methodological explorations. *Ecology and Society* 17(3):24. https://doi.org/10.5751/ES-04257-170324

Lynam, T., R. Mathevet, M. Etienne, S. Stone-Jovicich, A. Leitch, N. Jones, H. Ross, D. Du Toit, S. Pollard, H. Biggs, and P. Perez. 2012. Waypoints on a journey of discovery: mental models in human-environment interactions. *Ecology and Society* 17(3):23. https://doi.org/10.5751/ES-05118-170323

Mathevet, R. 2004. *Camargue incertaine: sciences, usages et natures*. Buchet-Chastel, Paris, France.

Mathevet, R., F. Bousquet, C. Larrère, and R. Larrère. 2018*a*. Environmental stewardships and ecological solidarity: rethinking social-ecological interdependency and responsibility. *Journal of Agricultural and Environmental Ethics* 31(5):605-623. https://doi.org/10.1007/s10806-018-9749-0

Mathevet, R., F. Bousquet, and C. M. Raymond. 2018*b*. The concept of stewardship in sustainability science and conservation biology. *Biological Conservation* 217:363-370. https://doi.org/10.1016/j.biocon.2017.10.015

Mathevet, R., M. Etienne, T. Lynam, and C. Calvet. 2011. Water management in the Camargue Biosphere Reserve: insights from comparative mental models analysis. *Ecology and Society* 16 (1):43. https://doi.org/10.5751/ES-04007-160143

Mathevet, R., J. D. Thompson, C. Folke, and F. S. Chapin III. 2016. Protected areas and their surrounding territory: socioecological systems in the context of ecological solidarity. *Ecological Applications* 26(1):5-16. https://doi.org/10.1890/14-0421

Mathevet, R., C. Vuillot, and C. Sirami. 2014. Effective nature conservation on farmland: Can we change our own models, not just the farmers? *Conservation Letters* 7:575-576. https://doi.org/10.1111/conl.12064

Matless, D. 2003. Introduction: The Properties of Landscape. Pages 227-232 *in* K. Anderson, M. Domosh, S. Pile, and N. Thrift, editors. *Handbook of cultural geography*. Sage, London, UK. https://doi.org/10.4135/9781848608252

Michel-Guillou, E., and G. Moser. 2006. Commitment of farmers to environmental protection: from social pressure to environmental conscience. *Journal of Environmental Psychology* 26:227-235. https://doi.org/10.1016/j.jenvp.2006.07.004

Moliner, P. 1993. Cinq questions à propos de réprésentations sociales. *Cahiers Internationaux de Psychologie Sociale* 20 (12):5-14.

Moliner, P., and J.-C. Abric. 2015. Central core theory. Pages 83-95 *in* G. Sammut, E. Andreouli, G. Gaskell, and J. Valsiner, editors. *The Cambridge handbook of social representations*. Cambridge University Press, Cambridge, UK. https://doi.org/10.1017/CBO9781107323650.009

Moliner, P., P. Rateau, and V. Cohen-Scali. 2002. *Les représentations sociales: pratique des études de terrain*. Presses Universitaires de France, Rennes, France.

Moloney, G., Z. Leviston, T. Lynam, J. Price, S. Stone-Jovicich, and D. Blair. 2014. Using social representations theory to make sense of climate change: what scientists and nonscientists in Australia think. *Ecology and Society* 19(3):19. https://doi.org/10.5751/ES-06592-190319

Moloney, G., and I. Walker. 2002. Talking about transplants: social representations and the dialectical, dilemmatic nature of organ donation and transplantation. *British Journal of Social Psychology* 41(2):299-320. https://doi.org/10.1348/014466602760060264

Morlot, R., and E. Salès-Wuillemin. 2009. Effet des pratiques et des connaissances sur la représentation sociale d'un objet: application à l'hygiène hospitalière. *Revue Internationale de Pyschologie Sociale* 21:89-114.

Moscovici, S. 1972. Society and theory in social psychology. Pages 66-91 *in* J. Israel and H. Tajfel, editors. *The context of social psychology: a critical assessment*. Academic, London, UK.

Moscovici, S. 1976 (1961). *La psychanalyse, son image et son public*. Presses Universitaires de France, Paris, France.

Moscovici, S. 1988. Notes towards a description of social representations. *European Journal of Social Psychology* 18:211-250. https://doi.org/10.1002/ejsp.2420180303

Moscovici, S., and I. Marková. 1998. Presenting social representations: a conversation. *Culture and Psychology* 4:371-410. https://doi.org/10.1177/1354067X9800400305

Moscovici, S., and I. Marková. 2000. Ideas and their development: a dialogue between Serge Moscovici and Ivana Markova. Pages 224-286 *in* G. Duveen, editor. *Social representations: explorations in social psychology.* Polity Press, London, UK.

Pasher, J., S. W. Mitchell, D. J. King, L. Fahrig, A. C. Smith, and K. E. Lindsay. 2013. Optimizing landscape selection for estimating relative effects of landscape variables on ecological responses. *Landscape Ecology* 28:371-383. https://doi.org/10.1007/s10980-013-9852-6

Pe'er, G., L. V. Dicks, P. Visconti, R. Arlettaz, A. Báldi, T. G. Benton, S. Collins, M. Dieterich, R. D. Gregory, F. Hartig, K. Henle, P. R. Hobson, D. Kleijn, R. K. Neumann, T. Robijns, J. Schmidt, A. Shwartz, W. J. Sutherland, A. Turbé, F. Wulf, and A. V. Scott. 2014. EU agricultural reform fails on biodiversity. *Science* 344:1090-1092. https://doi.org/10.1126/science.1253425

Perichon, S. 2004. L'impossible reconstruction des bocages détruits. *Espace Géographique* 33:175-187. https://doi.org/10.3917/eg.332.0175

Perichon, S. 2005. Les représentations sociales associées au bocage. Analyse des relations agriculteurs/territoire en haute-bretagne. *Bulletin de la Société Géographique de Liège* 46:71-80.

Plieninger, T., T. Kizos, C. Bieling, L. Le Dû-Blayo, M.-A. Budniok, M. Bürgi, C. L. Crumley, G. Girod, P. Howard, J. Kolen, T. Kuemmerle, G. Milcinski, H. Palang, K. Trommler, and P. H. Verburg. 2015. Exploring ecosystem-change and society through a landscape lens: recent progress in European landscape research. *Ecology and Society* 20(2):5. https://doi.org/10.5751/ES-07443-200205

Quétier, F., F. Rivoal, P. Marty, J. de Chazal, W. Thuiller, S. Lavorel. 2010. Social representations of an alpine grassland landscape and socio-political discourses on rural development. *Regional Environmental Change* 10:119–130. https://doi.org/10.1007/s10113-009-0099-3

R Core Team. 2014. R: *A language and environment for statistical computing*. R Foundation for Statistical Computing, Vienna, Austria.

Rateau, P. 1998. *Variable d'implication et évolution structurale d'une représentation sociale*. 4ème Conférence Internationale sur les Représentations Sociales, Mexico City, Mexico.

Raymond, C. M., J. O. Kenter, T. Plieninger, N. J. Turner, and K. A. Alexander. 2014. Comparing instrumental and deliberative paradigms underpinning the assessment of social values for cultural ecosystem services. *Ecological Economics* 107:145-156. https://doi.org/10.1016/j.ecolecon.2014.07.033

Roussiau, N., and C. Bonardi. 2001. *Les représentations sociales: état des lieux et perspectives*. Editions Mardaga, Sprimont, Belgium.

Salès-Wuillemin, E., R. Morlot, A. Fontaine, W. Pullin, C. Galand, D. Talon, and P. Minary-Dohen. 2011. Evolution of nurses' social representations of hospital hygiene: from training to practice. *European Review of Applied Psychology* 61:51-63. https://doi.org/10.1016/j.erap.2010.06.001

Sammut, G. 2015. Attitudes, social representations and points of view. Pages 96-112 *in* G. Sammut, E. Andreouli, G. Gaskell, and J. Valsiner, editors. *The Cambridge handbook of social representations.* Cambridge handbooks in psychology series. Cambridge University Press, Cambridge, UK. https://doi.org/10.1017/CBO9781107323650.010

Sammut, G., E. Andreouli, G. Gaskell, and J. Valsiner. 2015*a*. Social representations: a revolutionary paradigm? Pages 3-11 *in* G. Sammut, E. Andreouli, G. Gaskell, and J. Valsiner, editors. *The Cambridge handbook of social representations*. Cambridge University Press, Cambridge, UK. https://doi.org/10.1017/cbo9781107323650.003

Sammut, G., E. Andreouli, G. Gaskell, and J. Valsiner. 2015*b*. *The Cambridge handbook of social representations*. Cambridge University Press, Cambridge, UK. https://doi.org/10.1017/CBO9781107323650

Sammut, G., and C. Howarth. 2014. Social representations. Pages 1799-1802 *in* T. Teo, editor. *Encyclopedia of critical psychology*. Springer, New York, New York, USA. https://doi.org/10.1007/978-1-4614-5583-7_292

Scherr, S. J., and J. A. McNeely. 2007. Biodiversity conservation and agricultural sustainability: towards a new paradigm of 'ecoagriculture' landscapes. *Philosophical Transactions of the Royal Society B: Biological Sciences* 363:477-494. https://doi.org/10.1098/rstb.2007.2165

Sirami, C., N. Gross, A. Bosem Baillod, C. Bertrand, R. Carrié, A. Hass, L. Henckel, P. Miguet, C. Vuillot, A. Alignier, J. Girard, P. Batáry, Y. Clough, C. Violle, D. Giralt, G. Bota, I. Badenhausser, G. Lefebvre, B. Gauffre, A. Vialatte, F. Calatayud, A. Gil-Tena, L. Tischendorf, S. Mitchell, K. Lindsay, R. Georges, S. Hilaire, J. Recasens, X. Oriol Solé-Senan, I. Robleño, J. Bosch, J. A. Barrientos, A. Ricarte, M. A. Marcos-Garcia, J. Miñano, R. Mathevet, A. Gibon, J. Baudry, G. Balent, B. Poulin, F. Burel, T. Tscharntke, V. Bretagnolle, G. Siriwardena, A. Ouin, L. Brotons, J. L. Martin, and L. Fahrig. 2019. Increasing crop heterogeneity enhances multitrophic diversity across agricultural regions. *Proceedings of the National Academy of Sciences* 116 (33):16442-16447. https://doi.org/10.1073/pnas.1906419116

Swaffield, S. R. 1991. *Roles and meanings of 'landscape.' Dissertation.* Lincoln University, UK.

Thenail, C., and J. Baudry. 2004. Variation of farm spatial land use pattern according to the structure of the hedgerow network (bocage) landscape: a case study in northeast Brittany. *Agriculture, Ecosystems & Environment* 101:53-72. https://doi.org/10.1016/S0167-8809(03)00199-3

Tscharntke, T., A. M. Klein, A. Kruess, I. Steffan-Dewenter, and C. Thies. 2005. Landscape perspectives on agricultural intensification and biodiversity - ecosystem service management. *Ecology Letters* 8:857-874. https://doi.org/10.1111/j.1461-0248.2005.00782.x

Tsirogianni, S. 2014. Social values. Pages 1809-1812 *in* T. Teo, editor. *Encyclopedia of critical psychology*. Springer, New York, New York, USA. https://doi.org/10.1007/978-1-4614-5583-7_294

Valence, A. 2010. *Les représentations sociales*. De Boeck, Bruxelles, Belgium. https://doi.org/10.3917/dbu.valen.2010.01

Van Dijk, T. A. 2006. Politique, idéologies et discours. *SEMEN* 21:73-102.

Vergès, P. 1992. L'evocation de l'argent: une méthode pour la définition du noyau central d'une représentation. *Bulletin de Psychology* 45:203-209.

Vergès, P., Y. Bonnec, and N. Roussiau. 2002. Categorical and prototypical analysis: a study on the quality-process in hospital institutions. *European Review of Applied Psychology* 52:213-220.

Voelklein, C., and C. Howarth. 2005. A review of controversies about social representations theory: a British debate. *Culture and Psychology* 11:431-454. https://doi.org/10.1177/1354067X05058586

Vuillot, C. 2015. *Paysages agricoles et biodiversité dans les représentations sociales et les modèles mentaux des agriculteurs: une approche comparée de quatre régions françaises*. Dissertation. Human Geography, AgroParisTech and Université de Montpellier, Montpellier, France.

Vuillot, C., N. Coron, F. Calatayud, C. Sirami, R. Mathevet, and A. Gibon. 2016. Ways of farming and ways of thinking: do farmers' mental models of the landscape relate to their land management practices? *Ecology and Society* 21(1):35. https://doi.org/10.5751/es-08281-210135

Wachelke, J. 2011. Social representations: a review of theory and research from the structural approach. *Universitas Psychologica* 11(3):729-741. https://doi.org/10.11144/Javeriana.upsy11-3.srrt

Wachelke, J., and R. Wolter. 2011. Critérios de construção e relato da análise prototípica para representações sociais. *Psicologia: Teoria e Pesquisa* 27(4):521-526. https://doi.org/10.1590/S0102-37722011000400017

Wagner, W., G. Duveen, R. Farr, S. Jovchelovitch, F. Lorenzi-Cioldi, I. Marková, and D. Rose. 1999. Theory and method of social representations. *Asian Journal of Social Psychology* 2:95-125. https://doi.org/10.1111/1467-839X.00028

Wagner, W., and N. Hayes. 2005. *Everyday discourse and common sense: the theory of social representations.* Red Globe, London, UK.

APPENDIX 1. METHODS

Details on analysis methodology

In order to compare the consensus levels between different social groups, we adapted the model proposed by some socio-psychologists. This model allows to statistically test (with an α risk of 5%) if a word was more frequently uttered by participants than if they had each picked up *w* words randomly among all uttered words, the number *w* being imposed by the researchers (Salès-Wuillemin et al. 2011). We adapted this model to a more general case and we set $\boldsymbol{w}$ as a variable instead of a constant. $\boldsymbol{w}$ varies with each respondent $\boldsymbol{i}$, taking the value of the number of words that each respondent $\boldsymbol{i}$ chose to give ($\boldsymbol{w_i}$). Words that pass the test are considered as « consensual words".

The null model we used for the test is the following:

Considering the respondent $\boldsymbol{i}$; let us call $\boldsymbol{w_i}$ the number of word he/she uttered. Let us call $\boldsymbol{W}$ the total number of different words uttered by all the respondents and $\boldsymbol{I}$ the total number of respondent in our sample. The null hypothesis (i.e. the hypothesis that must be rejected for a word to be considered "consensual") is the following: given that $\boldsymbol{W}$, $\boldsymbol{I}$ and all the $\boldsymbol{w_i}$ are known, each word is likely to be picked up by respondents with the same probability $\boldsymbol{p_i}$. This probability (random pick up with replacement) equals:

$$\frac{\binom{W-1}{wi-1}}{\binom{W}{wi}} = pi$$

Consequently, the number $\boldsymbol{N_j}$ of times that the word $\boldsymbol{j}$ is cited among $\boldsymbol{I}$ respondent can be defined by:

$$Nj = \sum_{i=1}^{I} Xi \text{ with } Xi \sim B(pi)$$

Then we test for each word $\boldsymbol{j}$ wether or not its frequency of utterance ($\boldsymbol{N_j}$) is below the $(1-\alpha)$ quantile of the null model (with a chosen risk α= 5%).

However, given the high number of test necessary (one per word), we stress the necessity to control for false positive detection rates using Holm-Bonferroni p-value adjustment technique for multiple test procedure (Holm 1979). Otherwise the proportion of false positive detection rate would be α/W.

This adjustment technique is rigorous but increases a lot the false negative detection rate (Moran, 2003). Consequently we coupled this approach with a reduction of the number of tested words (i.e. reducing $\boldsymbol{W}$) and tested only words that were uttered by at least 10% of the respondents.

Details on the categorization process

During the free listing tasks, farmers were free to cite, any word or group of words they liked with no restriction on the total number of words. This led to a great variety of uttered items. The themes were built after creating a semantical classification of words. Then emerging themes as well a theme of interest we defined to build the different categories. This step is defined by Vergés as a "merger between the researcher's own categorization system and what seems to emerge from the data" (Vergès 1992). Our categorical evaluation grid was the same across study sites and free listing tasks to allow comparing sites and representations. It was established for all items by the same researcher (CV) and crosschecked by another (RM) for

consistency. Below are some examples of aggregated categories. The weight of a category represents the number of prototypes it contains.

Table A1.1 Thematic categories (in English) and their prototypes (in French). The WEIGHT indicates the number of words that each category contains.

THEMES	WEIGHT	Prototypes
Lived-in landscape	**40**	agréable ; agrémenté ; aider ; attaché ; vie au travers de ; bien-être ; chez ; concentré ; CUMA ; difficile ; espacé ; familial ; gens ; grand ; habitué ; impression ; incompris ; individuel ; intégration ; jeune ; liberté ; loin ; mauvais ; odeurs ; pas bon ; pas génial ; petit ; population ; qualité ; réconfortant ; s'entraider ; s'installer ; solidarité ; solitude ; sympa ; tranquille ; vacances ; vide; vivant
pattern and layout	**35**	10 15 ha ; 2 - 3 ha ; agrandissement ; carré ; cases du ; damier ; disposition ; emplacement ; est ouest ; forme ; grand ; gros ; maillage ; morcelé ; morcellement ; orienté ; parcellaire ; parcelle ; parsemé ; patchwork ; petit ; plus ; regroupé ; regroupement ; regrouper ; SAU par exploitation ; structure ; structuré ; suivent ; superficie ; surface ; taille ; terrain ; terre ; terres
crop type	**26**	à paille ; d'antan ; blé ; blé d'hiver ; blé dur ; céréales ; céréales d'hiver ; céréalier ; colza ; couverts ; grandes cultures ; maïs ; oléo-protéagineux ; orge ; permanent ; riz ; rizicole ; riziculture ; rizière ; sec ; sorgho ; tournesol ; type ; végétal ; végétaux ; vigne
esthetics	**25**	banal ; bardé bois ; beau ; beauté ; blanc ; charme ; couleur ; en accord ; fade ; formé par ; homogène ; intégration ; jaune ; joli ; lumière ; monotone ; pas trop mal ; propre ; pureté ; reflet ; riche ; tableau ; uniforme ; verdure ; vert
topography	**24**	accidenté ; bas ; bourrelet ; collinaire ; collines ; coteaux ; creux ; descend ; escarpé ; montagne ; monte ; pente ; plaine ; plan ; plat ; platitude ; relief ; terrain ; topographie ; tortueux ; vallée ; vallon ; vallonnement ; vallonné
territorial identity, culture, tradition	**23**	artisanal ; Beauce ; breton ; Camargue ; canton ; comminges ; culture ; délimité ; Gers ; Landal ; Landes ; le coin ; normand ; notre ; nous ; particulier ; pays ; poitevin ; région ; restreint ; terre ; tradition ; typique
profession, agricultural practices	**22**	abandon ; aisé ; amélioration ; amélioré ; avantageux ; bureau ; difficile ; difficulté ; facile ; méthode ; métier ; passion ; plus ; procédure ; rien ; rotation ; temps ; tout ; travail ; travaillable ; travailler ; vocation
agriculture	**21**	agricole ; agriculture ; ail ; amont ; aval ; coopérative ; cultivé ; cultural ; culture ; cultures ; exploitation ; ferme ; légumier ; maraichage ; melon ; nu ; polyculture ; représentativité ; représenté ; structure ; utilisé
evaluative judgement	**21**	95 pour cent ; à la marge ; assez ; beaucoup de ; densité ; développé ; dominant ; faible ; moins ; multitude de ; nombreuses ; peu ; peu de ; plus ; plutôt ; prédominance ; richesse ; très ; trop ; un peu ; une personne pour trois
wild nature, biodiversity	**20**	biodiversité ; canard ; chevreuil ; écosystème ; enganes ; espèce ; faune ; flamands roses ; flore ; friche ; gibier ; lande ; nature ; naturel ; oiseau ; roseau ; roseaux ; sansouïre ; sauvage ; végétation
planning, maintenance	**19**	aménagé ; aménagement ; assainissement ; dessiné ; entretenu ; entretien ; façonné ; maintient ; mis en place ; modification ; modifié ; nivelé ; plantation ; remembrement ; replantation ; replanter ; restructuration ; restructuré ; transformation
human activity	**18**	actif ; activité ; artificialisation ; artificiel ; comment ; création ; déviation ; dynamique ; emploi ; entreprise ; homme ; humain ; par accident ; par l'homme ; pluriactif ; société ; tout ; utilisation

diversity, contrasts	**17**	contraste ; de tout ; différence ; différent ; différente ; diverse ; diversification ; diversifié ; diversité ; entre ; hétérogène ; mixte ; moitié ; nuances ; ou ; plus ; varié
evolution	**16**	années 68 ; années 80 ; augmentation ; baisse ; change ; changement ; en fonction ; évolution ; gros ; moins ; moins en moins ; mutation ; nouveau ; photographie ; plus de ; stabilité
water management	**16**	amener ; canal ; digue ; domestiqué ; en eau ; évacuer ; fossé ; gérer ; hydraulique ; inondé ; irrigation ; irrigué ; maitrise ; réseau ; résolution ; roubine
soil quality	**16**	basses ; calcaire ; cultivable ; haut ; pauvre ; pierre ; qualité ; réserve utile ; riche ; salé ; sel ; sol ; terre ; terrefort ; terres ; texture
water	**15**	Aussoue ; captage ; Courance ; cours d'eau ; doux ; eau ; flotte ; Guirande ; Mignon ; Rhône ; rivière ; ruisseau ; salé ; Save ; Touch
livestock farming	**13**	agneau ; animaux ; bêtes ; bovins ; brebis ; chevaux ; chèvre ; cochon ; élevage ; mouton ; race ; taureau ; vache
view sight skyline	**12**	éloigné ; étendue ; grand ; horizon ; ligne de crête ; ouvert ; panorama ; perspective ; visage de ; vision ; voir ; vue du ciel
villages, built environment	**11**	bâti ; bourg ; château ; communes ; habitat ; hameau ; lotissement ; maison ; mas ; village ; ville
trees hedges, bocage	**10**	arbre ; arbuste ; aspect ; bocage ; bocager ; bord ; haies ; plant ; talus ; tamaris
climate, seasons	**10**	aride ; climat ; été ; hiver ; printemps ; saison ; saisons ; sec ; tempéré ; vent
environment	**9**	adaptation ; adapté ; coexistence ; conditions ; environnement ; environnemental ; résistant ; retenue ; vert
woods, forests	**8**	lisière ; taillis ; bois ; boisé ; boisement ; chaniasse ; forêt ; peupleraie
altered deteriorated	**8**	abattre ; bouleversé ; destruction ; détérioration ; détruit ; massacré ; pollution ; ravinement
places, areas	**8**	bassin de ; espace ; espaces ; milieu ; région ; sur le reste ; surface ; zone
grass, meadows	**8**	fourrager ; herbage ; herbe ; luzerne ; naturel ; prairie ; prés ; verdure
lack of	**6**	aucun ; lacunes ; non ; pas ; pas assez ; pas de
farmers, peasants	**6**	actif ; agriculteurs ; céréalier ; éleveur ; paysan ; repiqueur
agricultural decline, land abandonment	**5**	abandonné ; chômage ; clairsemé ; diminution ; reprise
extensive	**5**	autour ; dans ; dehors ; en pâture ; extensif
normative judgement	**5**	besoin de ; falloir ; harmonie ; mal ; raisonnable
agricultural production	**5**	allaitant ; laitier ; production ; utile ; viande
wetlands	**5**	étangs ; humide ; lac ; marais ; marécage
access, travel	**4**	accès ; chemins ; randonnée ; route
countryside	**4**	campagne ; champêtre ; champs ; rural
constraints, issues	**4**	contraintes ; problématique ; problème ; surcoût
public policies	**3**	administratif ; MAE ; règlementation

demonstrative pronoun	**3**	c’est ; ça ; ce que
tourism	**3**	tourisme ; touriste ; touristique
natural disaster	**2**	cataclysmes ; inondation
commerce, industry	**2**	commercial ; industriel
desert	**2**	désert ; désertique
balance	**2**	équilibre ; équilibré
intensification	**2**	augmentation ; intensif
respect, care	**2**	important ; respect

R Script to calculate thresholds and conduct the rank-frequency analyses

Below is an example of data table with the type of formatting that this script needs (Figure A1.1.):

First column: Named "**ID**" is contains the unique identification number associated with each respondent

Second column: named "**RAW**" is contains raw data, i.e. the words uttered by respondents in the form they chose (plural or singular, with typographical errors as the case may be, etc.)

Third column: named "**RANKING**" contains for each words its apparition rank, the first word uttered by a respondent get the rank 1, the second word he or she uttered gets the rank 2, etc.

Fourth column: named "**PROTOTYPICAL**", it contains prototypes associated with each uttered word, all prototypes are at the infinitive, singular, masculine form when need be. Whenever people used group of words that are not an expression (for example "beautiful forest") it must be considered as two prototypes the line must be duplicated, the rank of both prototypes is the same (the rank of the expression uttered by the respondent). When group of words are a known expression (e.g. "climate change"), it must be kept as one prototypes and put together with a dash.

Fifth column: "**THEMATICAL**" used for the categorical analysis, it contains for each uttered word the broader category it has been associated to by the researchers

Sixth, seventh and eighth columns: these are used to compare sites, social groups or inductor item (THEME).

ID	RAW	RANKING	PROTOTYPICAL	THEMATICAL	SITE	GROUP	THEME
1	hills	1	hill	topography	Camargue	F	agricultural-landscape
1	bird	2	bird	wild_fauna	Camargue	F	agricultural-landscape
1	beautiful	3	beautiful	esthetic	Camargue	F	agricultural-landscape
2	forests	1	forest	seminatural_habitat	Camargue	F	agricultural-landscape
2	cows	2	cow	livestock_farming	Camargue	F	agricultural-landscape
2	birds	3	bird	wild_fauna	Camargue	F	agricultural-landscape
2	hedge	4	hedge	seminatural_habitat	Camargue	F	agricultural-landscape
2	sunflowers	5	sunflower	cultivated_crops	Camargue	F	agricultural-landscape
3	wheat	1	wheat	cultivated_crops	Camargue	F	agricultural-landscape
3	beautiful forest	2	beautiful	esthetic	Camargue	F	agricultural-landscape
3	beautiful forest	2	forest	seminatural_habitat	Camargue	F	agricultural-landscape
4	climate change	1	climate-change	climate	Camargue	F	agricultural-landscape

Figure A1.1 Example of data file needed for the R script

 # measuring and comparing social representations
#
==========

Workspace Setting
root<-"C:/Users/" # set here the working directory

library(vegan)

CHOICE OF THE SCRIPT PARAMETERS
Theme <-"agricultural-landscape" # Indicate here the inductor word used for the free-listing task to be analysed

Site <-"Camargue" # Indicate here the name of the study site or "all" in order to pool all words from all sites together

Group <-"F" # Indicate here the social group concerned by the free-listing task (here "F" for Farmers)

opt.cat <- "PROTOTYPICAL" # Indicate here the level of categorization of the words chosen for the analysis (ex: PROTOTYPICAL for prototypical analysis or THEMATICAL for categorical analysis)

type.rang <-"apparition_Rank" # "apparition_rank"" or "importance_rank""

T <-0.1 # Indicate here the arbitrary frequency threshold (cutting point) to be used if the binomial threshold is too conservative; default data = 10%

type.freq<-"median" # choose "mean" or "median" for the crital frequency that separate central core words from the others

changes<-"yes" # when you run the script for the first time and then whenever you change the values of "theme" or "Site" or "Groupe" or "Opt.cat" set the value to "yes". In other case, set the value to "no"

Loading data
data <- read.delim(paste(root,"your-file.txt", sep=""), header=TRUE, stringsAsFactors=FALSE, sep="\t") "# indicate here the name of you text file

data.order <- data[order(data$ID),]

if (Site != "all") {t.words.cat<-data.order[which(data.order$SITE==Site & data.order$GROUP==Group & data.order$THEME==Theme),]}

if (Site == "all") {t.words.cat<-data.order[which(data.order$GROUP==Group & data.order$THEME==Theme),]}

Creating a presence - absence matrix and an order matrix
# Order matrix
key.agents <- sort(unique(t.words.cat[,"ID"]))

key.cat<-sort(unique(t.words.cat[,opt.cat]))

Ranks<-matrix(0,nrow=length(key.agents),ncol=length(key.cat))

colnames(Ranks)<-key.cat

rownames(Ranks)<-key.agents

```
for (i in 1:nrow(t.words.cat)){
   indiv<-t.words.cat[i,"ID"]
   cat<-t.words.cat[i,opt.cat]
   rg <- t.words.cat[i,"type.rang"]
  if (Ranks[indiv,cat]==0 | Ranks[indiv,cat]>rg){Ranks[indiv,cat]<-rg }
}
# Presence - absence matrix
Freq  <- (Ranks>=1)*1
```

Calculation of the Binomial Threshold

```
## Calculation of parameters for the null model
# M is the total number of different words uttered by all individuals in the study
# A is the number of individuals in the study
# mi is the number of words uttered bu the individual i
M<-ncol(Freq)
M
A<-nrow(Freq)
A
m<-as.vector(apply(Freq,1,sum))
m
## Calculation of the number of times a word j is uttered among all individuals in the study : Nobs
Nobs<-as.vector(apply(Freq, 2, sum))
Nobs.class<-sort(Nobs, decreasing=TRUE)
Nobs.class
hist.obs<-hist(Nobs,breaks=(0:(max(Nobs)+1)-0.5),plot=FALSE)
x11()
plot(hist.obs$mids,hist.obs$density,type="l",xlim=c(0,max(hist.obs$mids)),ylim=c(0,max(c(hist.obs$density)))
   ,xlab="Number of citations", ylab="Density of probability",lwd=1.5)
 legend(4,0.4,"Nobs",lty=c(1,1),lwd=c(2,2))
```

```
### Calculation of frequencies and average ranking for each word
# Frequency of citation
Freq2<-apply(Freq,2,sum)

Freq.vect<-as.vector(Freq2)

# Average Ranking
RanksNA<-ifelse(Ranks>=0,0,0)

for(i in 1:nrow(Ranks)){for (j in 1:ncol(Ranks)) {RanksNA[i,j]<-
ifelse(Ranks[i,j]==0,NA,Ranks[i,j])}}

Rg.moy<-colMeans(RanksNA, na.rm=TRUE)

Rg.moy.vect<-as.vector(Rg.moy)


# Data table = for each uttered words its frequency and average ranking
SR<-data.frame(cbind(Freq.vect,Rg.moy.vect), row.names=names(Rg.moy))

# Export data table

write.table(SR,paste(root,"SR_MF_rev_", Theme, "_", opt.cat, "_", Site,  "_", Group,".txt",
sep=""),sep="\t", dec = ",")


## The null Model
# each participant randomly picks up mi words among all words uttered by all the participants

# mi is the number of words he/she actually uttered diring the free-listing task

# when considering the raw uttered word, the null model is a "tirage sans remise" and the
probability for a word to be picked up p is p = 1 − (C_{M−1}^m / C_M^m) = m/M

# when considering the categorized data, one participant can pick up several words belonging
to the same category so that the null model become a "tirage avec remise" and p becomes p =
1 − ((M−1)/M)^m


p <- 1 - (((M-1)/M)^m) # true if opt.cat is different from "RAW" or "PROTOTYPICAL"

if (opt.cat == "RAW") {p <- m/M}

if (opt.cat == "PROTOTYPICAL") {p <- m/M}


p

length(p)

length(m)
```

```
## Calculation for each word j of its frequency of citation : Nj
Nobs<-as.vector(apply(Freq, 2, sum))

Nobs.class<-sort(Nobs, decreasing=TRUE)

Nobs.class


## Calculation of the number of words uttered by at least T people (see arbitrary threshold)
cut.arb<-T*A

M2<-length(Nobs.class[which(Nobs.class>= cut.arb)])


## Simulating what would happen if respondents randomly pick up the number of word they uttered among all word uttered. # simulate 20 000 random sampling

Z<-matrix(0,nrow=A,ncol=50000)

Nsimu<-rep(0,50000)

for (j in 1:ncol(Z))

  {

 while(sum(Z[,j])==0)

   {  for (i in 1:A)

    {

   Z[i,j]<-rbinom(1,1,p[i])

    }}

  }

Nsimu<-apply(Z,2,sum)

hist.obs<-hist(Nobs,breaks=(0:(max(Nobs)+1)-0.5),plot=FALSE)

hist.simu<-hist(Nsimu,breaks=(0:(max(Nsimu)+1)-0.5), plot=FALSE)


## graph
x11(title="Distribution de la fréquence de citation des words")

plot(hist.simu$mids,hist.simu$density,type="l",col="red",xlim=c(0,max(c(hist.simu$mids,hist.obs$mids))),ylim=c(0,max(c(hist.obs$density,hist.simu$simu)))

    ,xlab="Nombre de citations", ylab="Densité de probabilité",lwd=1.5)

lines(hist.obs$mids,hist.obs$density,type="l",lwd=1.5)

legend(4,0.4,c("Nobs","Nsimu"),lty=c(1,1),col=c("black","red"),lwd=c(2,2))
```

```
## Binomial Threshold (BT)
# The BT is a frequency threshold that represent : the lowest frequency of citation above which a word is unlikely (with a type I error rate alpha=0.05) to have been randomly picked up by respondents.


Nclass<-sort(Nsimu)

alpha<-0.05 # choose the type I error rate

cut.binom<-rep(0,M2)

for(i in M2:1)

{

cut.binom[M2-i+1]<-Nclass[(ceiling(50000*(1-(alpha/i))))]

}

cut.binom

x11(title="distribution observée de la fréquence de citation vs cut binomial et cut arbitraire")

plot(Nobs.class, ylim=c(0,max(c(Nobs[which(Nobs>=cut.arb)],cut.binom))))

lines(cut.binom,col="red2")

abline(h=cut.arb,col="blue")

legend(20,10, legend=c("cut binomial",paste("cut", T*100,"%"), col= c("red2","blue"), border="black", lwd=1))


# Critical Frequency (CF) = mean frequency of all word that reached the BT or above
words.cut.binom <- subset(SR, Freq.vect >= cut.binom[1])

CF<-mean(words.cut.binom$Freq.vect)

CF

# Arbitrary threshold
cut.arb<-T*A

# Take the minimum number between the Binomial Threshold (BT) and the arbitrary threshold (AT)
cut <- min(cut.binom, cut.arb)

# Median or Mean Frequency (MF) / NB: if BT = BT then MF = CF (Critical Frequency)
if (type.freq == "mean") {MF<-mean (words.cut$Freq.vect)}

if (type.freq == "median") {MF<-median (words.cut$Freq.vect)}

MF

# General Mean Rank
RMG<-mean(words.cut[,2])

RMG
```

Graphical outputs

```
# Keep only words uttered by C % of the people in the sample. C = cut = the appropriate threshold (arbitrary or binomial threshold)
SR2<-subset (SR,Freq.vect>= cut)

# Figure
x11()

plot(SR2[,1]~SR2[,2],

    xlim=c(min(SR2[,2])-1,max(SR2[,2])+0.7),

    ylim=c(min(SR2[,1])-1.5,max(SR2[,1])+0.5),

    xlab="Mean apparition rank",

    ylab="Frequency of citation",col="white",

    main= paste(Theme, Site, opt.cat, sep=" "))

abline(v=RMG,col="red")

abline(h=MF,col="blue")

abline(h=CF,col="darkgreen")

abline(h=cut[1],lty="dotted")

abline(h=cut.binom[1],lty="dotdash")


text(jitter(SR2[,2],2),jitter(SR2[,1],2), labels=rownames(SR2), cex = 1.3)

text(max(words.cut[,2])+0.5,MF+0.1,labels="MF",col="blue", cex = 0.8)

text(max(words.cut[,2])+0.5,CF+0.1,labels="CF",col="darkgreen", cex = 0.8)

text(max(words.cut[,2])+0.5,cut-0.1,labels="cut 10%",col="grey", cex = 0.8)

text(max(words.cut[,2])+0.5,cut.binom[1]-0.1,labels="binomial threshold", col="grey",cex = 0.8)

text(RMG-0.2,max(SR2[,1])+0.3,labels="RMG",col="red", cex = 0.8)
```

Measuring consensus level

```
# Binomial Threshold
cut.binom[1]

# General Mean Rank
RMG

# Median of Mean Frequency (depending on what was chosen earlier)
MF

# Number of Hapax
nb.Hapax<-length(Nobs.class[which(Nobs.class<2)])
```

```
nb.Hapax

# Number of consensual words
Consensus<-length(Nobs.class[which(Nobs.class>=cut.binom[1])])

Consensus

# Total number of words
M
```

Literature cited

Salès-Wuillemin, E., Morlot, R., Fontaine, A., Pullin, W., Galand, C., Talon, D., Minary-Dohen, P. 2011. Evolution of nurses' social representations of hospital hygiene: From training to practice. *European Review of Applied Psychology* 61(1) : 51–63. https://doi.org/10.1016/j.erap.2010.06.001

Holm, S. 1979. A simple sequentially rejective multiple test procedure. *Scandinavian Journal of Statistics* 6(2):65–70.

Moran, M.D. 2003. Arguments for rejecting the sequential Bonferroni in ecological studies. *Oikos* 100(2):403–405.

Vergès, P. 1992. L'évocation de l'argent: une méthode pour la définition du noyau central d'une représentation. *Bulletin de Psychology* 65(405):203-209.

APPENDIX 2. Description of the studied SESs

Details on the social-ecological contexts of our four SESs

a. The Camargue SES

Situated in the delta of the Rhône River on the French Mediterranean coast in southern France, the Camargue is a landscape of rice fields, reed beds, marshes, halophytic scrublands and lagoons (Mathevet 2004). Rice is the main crop, either in rotation with wheat or in monoculture, crop diversity being limited by soil salinity (Barbier & Mouret, 1992). Intensive rice farming has promoted the desalinization of uncultivated lands and the development of the hydraulic network, sometimes to the detriment of natural wetlands. This landscape also presents extensive livestock breeding on non-arable lands. Hedges have gradually disappeared due to land restructuration and use of aerial chemical treatments though helicopters (Mathevet et al. 2002). The Camargue represents one of the most important wetlands in Europe for migratory birds. It is protected by a Regional Nature Park, a conservation tool based on local political will, that promotes landscape and biodiversity through territorial coordination, concertation and AES contracts with farmers. It also has been designated by UNESCO as a World Heritage Site and a biosphere reserve.

b. The Plaine et Val de Sèvre SES

The "Plaine et Val de Sèvre" SES is a Long-Term Ecological Research (LTER) site located in Western France, southwest of Niort. The landscape is a grain-growing plain with intensive crop farming systems, mainly producing wheat, corn, sunflower, and rape (Agreste 2010). Over the last fifty years traditional mixed farming systems have been replaced by cereal systems only (Odoux et al. 2014) leading to a sharp decrease in meadows and grasslands. Agricultural intensification has also led to removal of most of the hedges since the 1960s (Berthet et al. 2012). Half of the study site has been designated as a Natura 2000 site according to the European Bird Directive (Figure A2.1). This conservation status allowed the implementation of local territorialized AES contracts with farmers on nearly 10,000 ha since 2011 (Odoux et al. 2014). These contracts are designed and managed by a local research center, especially to protect farmland birds.

c. The Armorique SES

The Armorique SES site is located north of Rennes, in Brittany in western France. It is a landscape of low hills with patches of woods and hedges. Farming systems are mainly dairy cattle systems based on sown and permanent grassland, fodder maize and cereals (Thenail 2002). Only 10% of the arable lands are permanent grassland, due to the spread of intensive enclosed breeding. The landscape presents a gradient of hedge density. It used to be an area of dense bocage (i.e. irregular-shaped fields separated by hedges and ditches with forests) but from the 1950s to the 1970s, several public funded land consolidation and field restructuring led to the destruction of trees and hedgerows (Perichon 2004). More recently, several public replantation programs, like “Breizh Bocage”, promote and fund replantation of hedges on part of the territory.

d. The Gascony Valleys and Hills SES

The Gascony Valleys and Hills SES is located 80 km southwest of Toulouse in southern France. The regional landscape is made up of steep hills and narrow valleys in a fine-scaled landscape mosaic of cropland, hedges, isolated trees and small forests. Natural constraints and the peculiarity of the local "house-based" social system have slowed down agricultural intensification and farm enlargement in this region (Choisis et al. 2010), maintaining mixed crop-livestock farming systems although farms are increasingly specializing in either crops or cattle (Ryschawy et al. 2012). There is no specific territorial policies to deal with landscape issues /or biodiversity conservation in this site. Some landscape diagnosis and planning have been conducted by official bodies at a larger scale but we found no evidence of any communication for the general public or any implementation at the local scale.

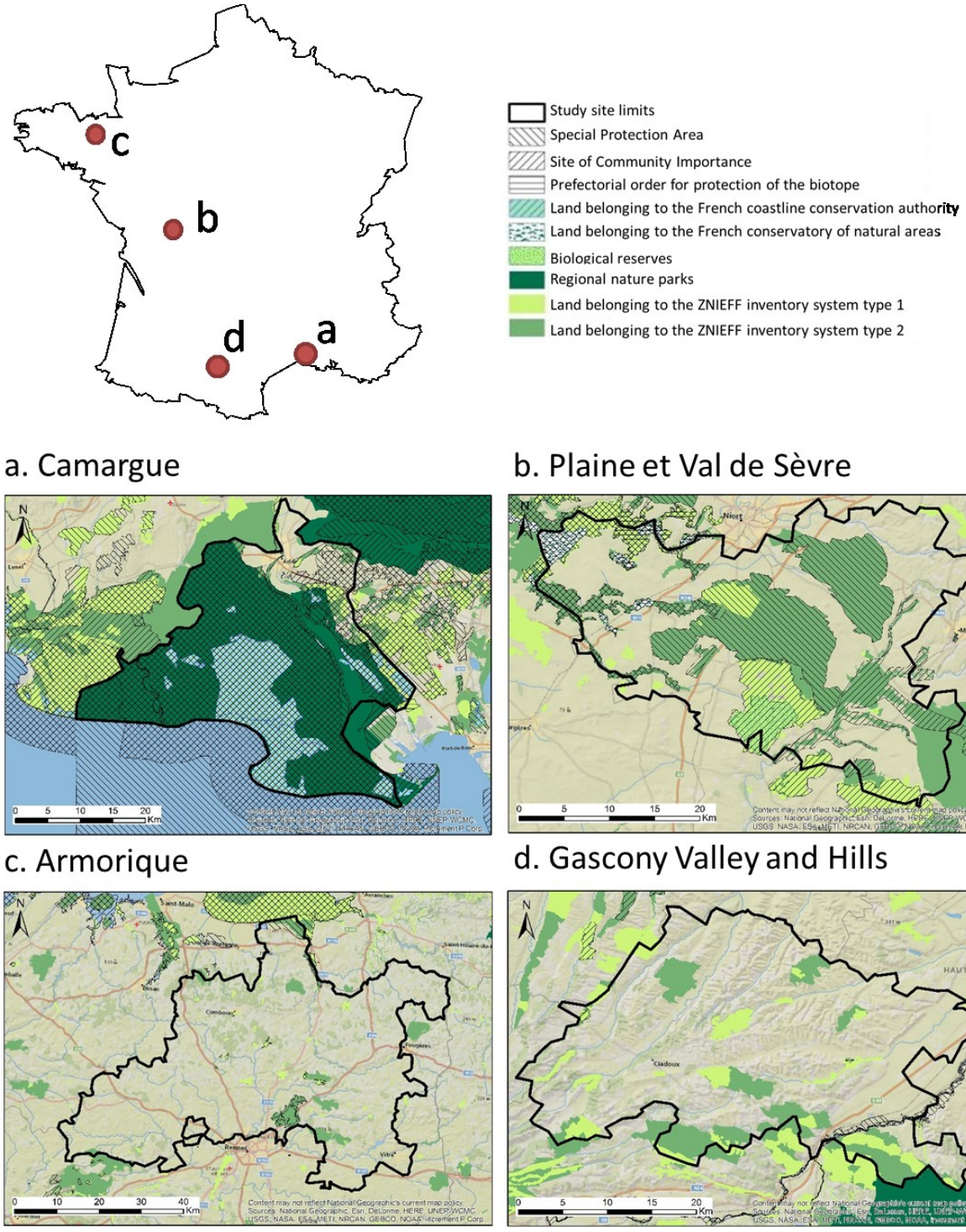

Figure A2.1. Local conservation policies on the four French study sites.

Details on sample characteristics in each SES

Table A2.1 Characteristics of sampled farmers based on studied SES. No. = Number; ND = No Data; AES = Agro-Environmental Scheme.

Study site	No. of farmers contacted (positive response rate)	Season of interview	No. of years of education after high school	age	% of farmers with organic farming practices	% of farmers who engaged in AES	% of farmers with livestock farming	% of farmers part of farmers' unions or other associations
Camargue *(n=30)*	55 (53%)	Spring	1,50 ± 2,12	52 ± 9	38%	53%	33%	70%
Plaine et Val de Sèvre *(n=30)*	40 (75%)	End of winter	0,03 ± 1,50	50 ± 10	17%	73%	53%	60%
Armorique *(n=30)*	49 (61%)	Beginning of winter	0,10 ± 1,67	47 ± 9	10%	*ND*	70%	57%
Gascony Valleys and Hills *(n=29)*	53 (57%)	Autumn	-0,10 ± 1,32	46 ± 10	10%	*ND*	79%	66%

Literature cited

Agreste. 2010. Recensement Agricole – 2010. Actualité et statistique agricole, Paris. https://agreste.agriculture.gouv.fr/agreste-web/

Barbier, J.M., and Mouret, J.C. 1992. Le riz et la Camargue. *INRA Mensuel* 64:39–51.

Berthet, E.T.A., Bretagnolle, V., Segrestin, B. 2012. Analyzing the Design Process of Farming Practices Ensuring Little Bustard Conservation: Lessons for Collective Landscape Management. *Journal of Sustainable Agriculture* 36:319–336. https://doi.org/10.1080/10440046.2011.627988

Choisis, J.P., Sourdil, A., Deconchat, M., Balent, G., Gibon, A. 2010. Comprendre la dynamique régionale des exploitations de polyculture élevage pour accompagner le développement rural dans les Coteaux de Gascogne. *Cahiers Agricultures* 19(2):97-103.

Mathevet, R. 2004. *Camargue incertaine: sciences, usages et natures*. Buchet-Chastel. Paris, FR.

Mathevet R., Tourenq C., and Mesléard F. 2002. Agricultural policies, land-use and waterbird conservation: the case study of a major Mediterranean wetland, the Camargue. *Cybergeo, The European Journal of Geography.* http://193.55.107.45/PAYSENVI/mathevet/mathevet.htm

Odoux, J.-F., Aupinel, P., Gateff, S., Requier, F., Henry, M., Bretagnolle, V. 2014. ECOBEE: a tool for long-term honey bee colony monitoring at the landscape scale in West European intensive agroecosystems. Journal of Apicultural Research 53(1):57–66. https://doi.org/10.3896/IBRA.1.53.1.05

Perichon, S. 2004. L'impossible reconstruction des bocages détruits. *L'Espace Géographique* 33 (2):175–187.

Ryschawy, J., Choisis, N., Choisis, J.P., Joannon, A., Gibon, A. 2012. Mixed crop-livestock systems: an economic and environmental-friendly way of farming? *Animal* 6(10):1722-1730.

Thenail, C. 2002. Relationships between farm characteristics and the variation of the density of hedgerows at the level of a micro-region of bocage landscape. Study case in Brittany, France. *Agricultural Systems* 71:207–230. https://doi.org/10.1016/S0308-521X(01)00048-8

APPENDIX 3. RESULTS

Results of the prototypical analysis

We present below the results of the prototypical analysis of the social representations of the "landscape" (APPENDIX 3 Table A3.1) and the "agricultural landcape" (APPENDIX 3 Table A3.2) before we conducted the categorization process.

Table A3.1 Prototypical analysis results: Farmers' social representation of the inductor item "landscape" based on study sites (frequency). Word cited by less than 10% of farmers within a given study site are not presented on this table.

		Camargue (n=30)		**Plaine et Val de Sèvre (n=30)**	
		First rankings	Later rankings	First rankings	Later rankings
Frequency	High	flat (10)* natural (6)*	water (8)* bulls (6)*	plain (15)* hedges (13)*	tree (5)*
	Low	landscape (4) expanse (3) wetland (3)	humid (4) rice (4) zone (4) horses (4) agriculture (3)	cereals (4) flat (4) green (3)	wetland (4) zone (3) crops (3) river (3) not (3)
		Armorique (n=30)		**Gascony Valleys and Hills (n=29)**	
		First rankings	Later rankings	First rankings	Later rankings
Frequency	High	wooded (9)*	bocage (9)* crops (6)*	hillsides (11)*	woods (5) livestock farming (5)*
	Low	agricultural (4) tree (4) banks (4) hedges (3) valley(3)	Land consolidation (4) livestock farming (4) plot (3) zone (3)	landform (4) hilly(4) grassland (4) valley (3) typical (3) diversity (3)	crops (4) landscape (4) river (3)

Note: The first number in parentheses indicates how frequently the induced word was associated to the inductor. Words followed by * are "consensual words" according to the binomial test.

Table A3.2 Prototypical analysis results: Farmers' social representation of the of the inductor item "agricultural landscape" based on study sites (frequency). Word cited by less than 10% of farmers within a given study site are not presented on this table.

		Camargue (n=30)		**Plaine et Val de Sèvre (n=30)**	
		First rankings	Later rankings	First rankings	Later rankings
Frequency	High	rice (9)* livestock farming (8)*		plain (9)* cereal (6)* large (5)* crops (4) plot (4)	cereals (6)* irrigation (4)
	Low	Plot (6)* rice field (6)*	crops (4) small (4)	agricultural (3) diversity (3) bocage (3)	livestock farming (3) corn (3) not (3) holding (3)
		Armorique (n=30)		**Gascony Valleys and Hills (n=29)**	
		First rankings	Later rankings	First rankings	Later rankings
Frequency	High	plot (7)* crops (6)* agricultural (5) land consolidation (5) not (5)	livestock farming (8)* livestock (5)	livestock farming (15)* grassland (9)* hillsides (7)* woods (4)	crops (8)* wooded (4)
	Low	fields (4) plot plan (4) wooded (3) tree (3) holding (3) corn (3) hedges (3)	wheat (4) grassland (3) replanting (3)	diversified (3) polyculture (3) cereals (3)	hedges (3) few (3) tree (3) a bit of everything (3) lands (3)

Note: The first number in parentheses indicates how frequently the induced word was associated to the inductor. Words followed by * are "consensual words" according to the binomial test.