Methods for Studying the Structure of Social Representations: A Critical Review and Agenda for Future Research

Grégory Lo Monaco, Anthony Piermatteo, Patrick Rateau, Jean-Louis Tavani

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Abstract

This article deals with the methodologies commonly used in the framework of the structural approach to social representations. It concerns free and hierarchical evocations, the characterization questionnaire, the similarity analysis, the basic cognitive schemes model, the attribute-challenge technique and the test of context independence. More than a simple review of these methodologies, it offers a critical approach concerning the problems encountered and related to: thresholds or "cutoff points" used to diagnose the structure (core vs. periphery) and the accuracy of the structural diagnosis, grouping methods employed to reduce the corpus of verbal associations, the dilemma between reliability and feasibility, especially in field research, the adequacy and number of modalities of response in the framework of the structural diagnosis. Following this evaluation, this article suggests potential solutions to overcome these methodological limitations. Moreover, as methodological issues are closely related to theoretical questions, the link between social representation theory and identity approaches is discussed.

Key words: social representations, core-periphery analysis, central core theory, methodology, identity approaches.

Introduction

Since the formulation of the theory of social representations (SRs; Moscovici, 1961, 2008) different approaches have been developed. Among these approaches, one can make reference for examples to the socio-genetic/anthropological approach, the socio-dynamic approach, the discursive approach and the structural approach (see Garnier, 2015, for a review of the different approaches and their relations). Several works have tried to present an exhaustive view of the state of the knowledge related to this theory and/or the various methodologies linked to it (Breakwell & Canter, 1993; Doise, 2005; Doise, Clemence, & Lorenzi-Cioldi, 1993; Doise & Palmonari, 1986; Jodelet, 1989; Rateau, Moliner, Guimelli, & Abric, 2011). However, most of these contributions focused on the SR theory in general and, to our knowledge, few of them specifically concerned the structural approach of SRs (Abric, 1994, 2003a). This is particularly the case for the chapters of the books edited by Breakwell and Canter (1993) and Doise et al. (1993). The problem is that there are only uncollected scientific articles concerning the methodologies developed and used in the framework of this theoretical approach and few of them are written in English. Yet, the structural approach constitutes one of the main developments of the theory (Garnier, 2015; Moliner & Abric, 2015; Rateau et al., 2011) and has led to methodologies frequently used in the literature. In fact, this approach has promoted numerous experimental works on SRs (Beauvois, 1997; Lo Monaco, Girandola, & Guimelli, in press; Rateau & Moliner, 2009) as well as being used in field research (Abric, 1994; Moliner, Rateau, & Cohen-Scali, 2002). Moreover, although there has been some evaluation of the SR theory (Hogg & Abrams, 1990; Potter & Litton, 1985) and the structural approach (Quenza, 2005), there is a surprising lack of works providing a critical appraisal of the methodologies, which are still frequently used. Such an appraisal could be considered an essential basis to determine the main pathways for

improving the methodologies related to the structural approach of SRs. In this perspective, the aim of this contribution is to update the presentation of these methodologies and to consider their limitations while presenting possible solutions to overcome them. We also propose a schematic presentation of each methods and a decision tree in order to give the opportunity to everyone who wants to use these methodologies to make his own choice.

The Structural Approach to Social Representations

The internal and structural organization of an SR was coined by Abric (1976). In line with his proposals, an SR can be considered as a structured and organized sociocognitive field. The whole SR is organized by a limited number of largely shared and consensual elements in a given social group (Abric, 1993, 2001; Lahlou & Abric, 2011; Moliner & Abric, 2015; Rateau et al., 2011). This limited number of cognitions is called the central core of the SR (Abric, 1993, 2001). Conversely, all the elements that do not belong to the central core are called "peripheral elements" but this point will be detailed below.

Thus, Abric (1993, 2001) formulated a theoretical model reflecting an important aspect of the structure of SRs. On this basis, the central core theory searches for structural invariants, which characterize the processes at stake in the genesis and dynamics of SRs. According to this model, the central core presents both a meaning-generating function and a meaning-organizing function. First, through the generating function, it diffuses its meaning to the whole representation. Secondly, by virtue of its organizing function, it determines the nature of the relationships between the elements of the representation. Lastly, it gives meaning to the object of representation and to the social practices related to it. Moreover, it has the characteristic of being strongly linked to the collective memory and the history of the group (Abric, 1993, 2001). It is stable, consistent and rigid, enabling it to be very resistant to

change and therefore rather insensitive to immediate context changes (Flament, 1995; Lo Monaco, Lheureux, & Halimi-Falkowicz, 2008; Wagner, Valencia, & Elejabarrieta, 1996; Skandrani-Marzouki, Lo Monaco, & Marzouki, 2015).

The central core itself is described as being composed of two dimensions defining the normative and/or functional nature of the elements (Abric, 1976; Guimelli, 1998a). When the elements are normative, it means that participants maintain no or little instrumental relationship with the object of representation and, more concretely, this reflects a lack of practice with respect to the latter. Normative elements are the framework on which the object is socially evaluated (Guimelli, 1998a). However, when individuals or groups have an instrumental link with the object of representation, the functional dimension is strongly activated. Moreover, there is evidence for mixed elements, both normative and functional, being involved in both practices and judgments (Guimelli, 1998a).

Around the central core, there are many peripheral elements depending on the weighting, the value or the function assigned by it. These elements perform several functions, such as making the central core concrete, regulating it and protecting it (Abric, 1993, 2001; Rateau et al., 2011). They regulate the largest informational content coming from the environment, which is likely to jeopardize the central core, and they defend the core by the conditional integration of contradictory elements. Thus, they allow the representation to be adapted by protecting the core, in most cases, from external constraints that could endanger its stability and coherence. They act as an interface between the core and the concrete situation in which SRs have meaning or play a role in everyday life action (Abric, 1993, 2001; Rateau et al., 2011). They enable an individualized SR to meet the needs of adaptation of individuals in their daily lives, without necessarily involving a structural change.

On the basis of these theoretical formulations, the issue for researchers working in the field of SR was, from the outset, to create or adapt methodologies capable of revealing the

structure and the internal organization of the representational field. With this objective, several methods and techniques have been developed. We will begin by presenting an overview of the different methods and discussing their advantages and limitations before concluding with an agenda for future research.

Methods for Studying the Structure and Organization of Social Representations

The methods described below may be classified into several categories (see Table 1) on the basis of the crossing of three criteria, that is the opportunity or not to identify (a) the content of the SR, (b) its structure, and (c) the nature of the elements composing the central core (i.e., functional vs. normative vs. mixed, see Guimelli, 1998a).

Table 1: *Classification of the methods used in the structural approach based on content identification, structural diagnosis and nature identification criteria.*

Content identification?	**Structural diagnosis?**	**Nature identification?** Yes	No
Yes	Yes	BCS*	-
	No	-	Research interview; associative maps; associative network; prototypical analysis and hierarchical evocations (hypotheses of centrality)
No	Yes	-	ACT, TCI, ASI
	No	-	Similarity analysis; Q. Sort questionnaire (hypotheses of centrality)

* The content identified by means of this method may concern the object under study but, in most cases, it concerns associations related to one or more elements of the representation.

As can be seen in Table 1, among the methods developed and used in the framework of the structural approach, none fully satisfies all the criteria laid down because none of them allow at the same time to identify the content, its structure and the nature of the central elements (i.e., functional vs. normative vs. mixed). However, as we can see the BCS model may offer this possibility but in order to identify the nature of the central elements, it requires a first step for locating central and peripheral elements and a second one to identify their nature. In order to cope with this limitation, researchers have to make choices or combine methodologies in order to carry out their investigations. In addition, most of them are characterized by limitations that entail adopting a critical approach. In this perspective, we shall present these methods by highlighting their limitations and, where possible, the solutions envisaged to overcome them in the framework of future research.

Verbal Association Tasks

Word association tasks constitute one of the main methods for collecting the content of SRs. It can be supported by a number of studies dealing with various objects of SR whose content has been revealed by verbal associations (for recent works see Dany, Urdapilleta, & Lo Monaco, 2015; Jung & Pawlowski, 2014, 2015; Mäkiniemi, Pirttilä-Backman, & Pieri, 2011; Mouret, Lo Monaco, Urdapilleta, & Parr, 2013; Piermattéo, Lo Monaco, Moreau, Girandola, & Tavani, 2014; Pozzi, Fattori, Bocchiaro, & Alfieri, 2014; Roland-Levy, Lemoine, & Jeoffrion, 2014; Salès-Wuillemin et al., 2011; Tavani, Zenasni, & Pereira-Fradin, 2009). Two methods are based on this type of task: free associations and hierarchical evocations (see Dany et al., 2015 for a recent review).

From a methodological point of view, as an example, in order to proceed by means of hierarchical evocations, we need to ask participants to associate the *n* words or phrases that

come to mind when we say "X". "X" relates to the object of representation under study. In the next step, participants have to hierarchize their words or phrases from the most to the least important. Note that in the case of free associations, research does not proceed to the hierarchizing phase, but considers the rank of appearance of the words or phrases (see Dany et al., 2015 for a recent review).

As this method is based on the idea that central core elements are more salient than others (Vergès, 1994), it is possible to take into account two types of criteria for each word or phrase, its frequency and its average importance in the case of hierarchical evocations (see Figure 1 for an example) and average rank of appearance in the case of the prototypical analysis. More precisely, through a prototypical analysis (Bonnec, Roussiau, & Vergès, 2002; Dany et al., 2015; Vergès, 1992), it is therefore possible to highlight the salience of certain elements of the representation by crossing two independent criteria: the frequency of occurrence and the rank of appearance (Vergès, 1992). As we have seen, participants are only asked to associate *n* words, or phrases, with the inductor, which is not the case in the method of hierarchical evocations (see Dany et al., 2015). In the latter method, participants have the opportunity, but are not obliged, to revise their production and rank the words in terms of importance. The frequency can be considered a quantitative and collective criterion, while the rank of occurrence/importance is regarded as a qualitative criterion, which is expressed by the subject through the order of appearance/importance.

Based on the distinction between high and low values relative to these two criteria, a double-entry table can be built (see Figure 1). The cell containing the most common elements and those that were mentioned among the first (low rank or high importance) will be the most salient. These elements are then considered "candidates for the central core" (cell 1), meaning that they have the highest chance of being part of the core. Then, the other elements are

generally distributed in the remaining cells, which are also related to a specific status characterizing the elements (see Abric, 2003b; Vergès, 1995).

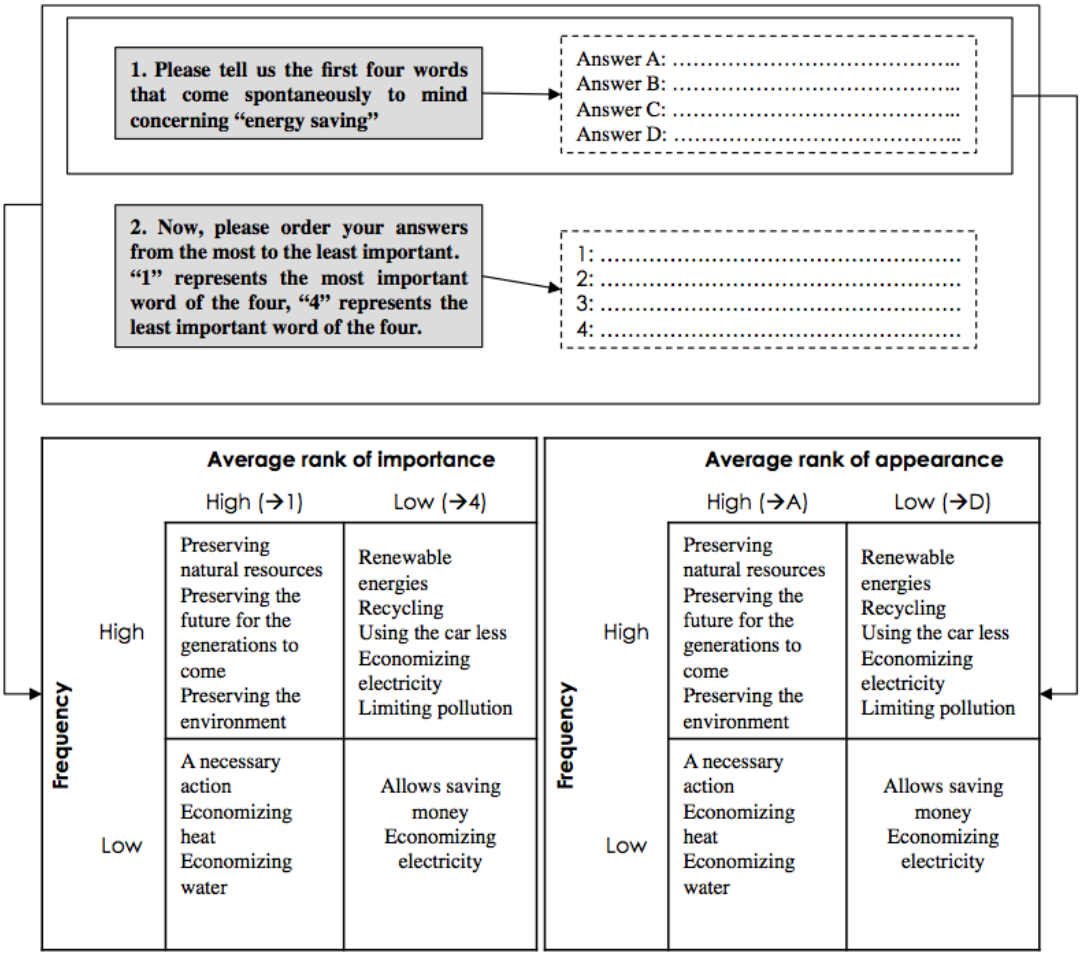


Figure 1. Fictitious example of the procedure of the frequency/importance vs. appearance method (adapted from the content collected by Souchet & Girandola, 2013).

Limitations and future research.

The first limitation concerning this methodological option is the recurrent dilemma for the researcher of choosing between reliability and feasibility. Clearly, content identification is a

fundamental and *sine qua non* step for all SR studies. It enables the representational field (i.e., the sociocognitive universe of the object under study) to be identified. The content of the representational universe can be investigated through different materials: verbal, iconic, etc. This first step should be completed by a structural diagnosis, but SR studies often consist of field studies and external constraints can influence the researcher. He/she cannot always choose how many times he/she can access the population and plan two data collections: first to identify the content, and secondly to diagnose the structure. It thus becomes difficult to provide accurate and reliable conclusions. In such cases, the researcher may still use a method that collects the content using the hierarchical evocation (Abric, 2003b). In fact, the prototypical analysis and the method of hierarchical evocations (see Dany et al., 2015 for a review) provide access to the content but, as we have seen, this methodological option only addresses hypotheses of centrality. Thus, given the issue of the determination of both rank and frequency thresholds and the arbitrary definition of the latter, this method is not an autonomous one and cannot diagnose the structure of an SR. This weakness was identified by Abric (2003) who considered that only some elements of the area of centrality were central. Thus, it remains to be discovered which elements among the potential central ones are effectively part of the core, which seems impossible based on the current state of knowledge related to this methodology. In addition, methodological changes (using rank of appearance vs. rank of importance, see Dany et al., 2015) lead to questions about the optimal choice to use and, currently, as rightly emphasized by Dany et al. (2015), it seems difficult to decide. Moreover, the variations observed in different publications (e.g., Dany et al., 2015; Lo Monaco & Guimelli, 2008; Tavani et al., 2009) prevent an indication of a clear and definitive threshold guaranteeing the reliability of the conclusions, for the frequency, the rank and the importance. Most often, the results obtained using hierarchical evocations need to proceed to a test of hypotheses using a test of centrality (Abric, 2003a).

A second limitation refers to the meaning attributed by the participants to their associations. Methods based on the principle of verbal associations in studies of SR (i.e., free associations or hierarchical evocations) assume the evocation of *n* terms (i.e., words or phrases) by each participant. As all the participants associate different words, the number of different terms will be equal to *n***N*, where *N* is the total number of participants. However, in practice, it is quite difficult to consider such a case. In fact, some words are very often subject to a consensus, they are expressed by several people and in the same form (e.g., two participants who mention the term "alcoholism" as part of the SR of alcohol). Nevertheless, it frequently (not to say systematically) occurs that close terms can be grouped according to their semantic proximity, despite their greater or lesser morphological differences (e.g., "alcoholic" and "alcoholism"), which is referred to as a phase of lemmatization (Di Giacomo, 1980). In this context, the meaning of each term could be an issue. Most of the time, studies do not describe the data collection procedure, they just give the name of the method, the number of words requested and the number of participants. Nevertheless, it is clear that the raw frequencies of words are rarely used and a preliminary phase of "thematic grouping" is carried out. As we will see, this consists of regrouping close terms (based on their meaning) and can be considered one of the most essential steps of the analysis of verbal associations. It is precisely this thematic grouping phase that leads us to formulate a critique and a potential methodological solution. Obviously, if clusters were built only on the basis of the morphological proximity of the terms, this would lead to few or no problems. However, the corpus can also be reduced on the basis of semantic aspects. Before going further, it should be noted that we do not disagree with a reduction based on semantic proximity but we wonder about the method (or its absence) related to such a reduction. Indeed, grouping terms on the basis of semantic proximity entails knowing at least what is the meaning given to the word and, more precisely, what is the meaning attributed to the relationship between the associated

word and the inductor. In this context, it is clear that, as we will see further, apart from the recommendations of Guimelli (1993, 2003) in the framework of the BCS model, no research into the structural approach insists on such caution. Recently, Piermattéo et al. (2014) used a phase called "semantic contextualization" in which they asked the participants to write a sentence expressing the meaning that they wished to assign to their association in relation to the inductor. To date, nothing is known about its capacity to facilitate thematic groupings and whether it makes it more reliable than the simple mention of the terms associated with the object. However, methodological research may be considered in order to verify if such a procedure improves these aspects. This work is currently underway and involves comparing, on the one hand, inter-judge agreement on the identification of thematic categories and, on the other hand, the inclusion of any such association in any particular category (using a judge's method). In addition, several indicators in terms of perceived difficulty or ambiguity of the terms could be measured. This could be a key aspect of studies in the structural approach of SRs since they are mostly based on a first step of verbal associations and the reliability of the interpretations depends on the decisions taken at this step of thematic grouping.

Q. Sort Questionnaire/Questionnaire of Characterization

The characterization questionnaire is an adaptation of the Q. Sort method (Stephenson, 1935) to the study of the structural approach of SRs (Flament, 1981). In practice, the participants are asked to make choices by blocks from an item list. For example, from a list containing twenty items, they must identify the four items that best match their representation of the object and assign them, for example, the score of +2. Then, from the remaining items, they must select four items that are the furthest from their representation and assign them the score of -2. Then again, they must identify the four items that match their representation of the object fairly

well (score of +1). Then, from the remaining items, they must select four items that match their representation poorly and assign them the score of -1. Finally, the remaining four items are scored 0. Each item is thus weighted on a 5-modality scale. This technique can also be based on 3 blocks instead of 5 (see Figure 2 below).

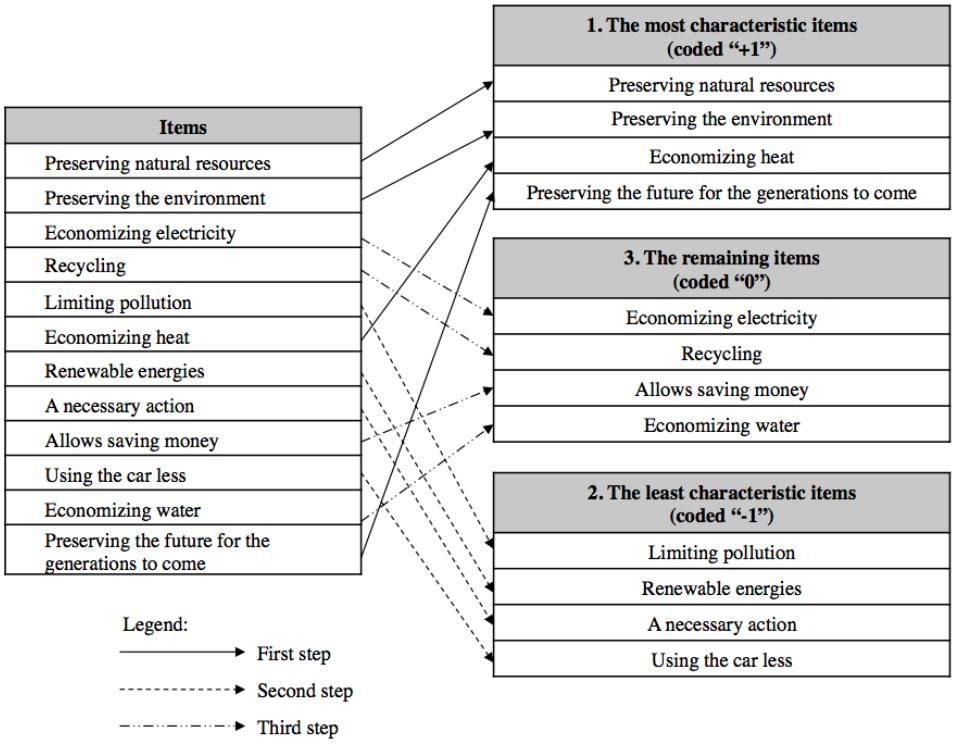


Figure 2. Fictitious example of the procedure of the Q. Sort Questionnaire concerning the social representations of energy saving (adapted from the results obtained by Souchet & Girandola, 2013).

The questionnaire of characterization offers several possibilities for data analysis. It enables the actual oppositions within the representational field to be observed. In this perspective, it is possible to use a correspondence factor analysis (Lo Monaco, Piermattéo, Guimelli, & Abric, 2012), taking into account the frequency of each of the three modalities of response (the most representative; the least representative; not chosen) as a categorical

dependent variable and examining the correspondences between these frequencies and the independent variables. As highlighted by Lo Monaco et al. (2012), this enables centrality hypotheses for subgroups to be formulated and social anchoring to be considered within the framework of the study of the structure of SRs. In this way, it provides the possibility of creating connections with other theoretical perspectives that particularly focus on social anchoring (Doise, 1990; Doise et al., 1993). This method not only enables an average mean to be obtained for each of the items tested and oppositions to be highlighted but also allows other analyses to be performed that reveal the internal organization of the representational field. To illustrate this aspect, the work of Guimelli (1998b), carried out on the SR of hunting practices, used this questionnaire to explore the relationships between the items in his study within a group of hunters by means of a similarity analysis.

Similarity Analysis and Basic Cognitive Schemes

The similarity analysis and the Basic Cognitive Schemes model (BCS) are two methods specifically based on the idea that an SR is a set of cognitive elements, interconnected with each other (Flament & Rouquette, 2003). These methods concern the relationships between the elements composing the representational field.

Similarity analysis.

The similarity analysis is based on the criterion of connexity, which represents the idea that, between two elements of representations, there may be a greater or lesser relationship. This can be assessed by the co-occurrence or the co-appearance of the elements in a verbal production of the subject (e.g., speech, interview, responses to a task of verbal associations). Thus, between two cognemes A and B, a relationship index can be calculated based on the

number of times these two elements have been connected by the subject. This is known as quantitative connexity.

The similarity analysis is based on the criterion of co-occurrence between the cognemes of representation and was the first method of data analysis in this field to take connexity into account (Flament, 1981; Flament & Rouquette, 2003; see Jung & Pawlowski, 2014, 2015 for recent use). It is usable on data collected by means of word association tasks and may involve different types of indices[1], notably the similarity index, based on the co-occurrence of two elements in a corpus, and the Distance index (i.e., the "D" index proposed by Guimelli, 1998b)[2].

Note that the "D" index requires the prior use of the characterization questionnaire. However, it reports only the quantitative and not the qualitative links of connexity. Moreover, while salience and high connexity are characteristics of the central elements of an SR, it is not possible to consider a cognition as central only on the basis of these two properties.

Thus, although the similarity analysis identifies whether the elements "get along well" or "do not get along well" (Flament, 1981; Flament & Rouquette, 2003), it does not determine the nature of the link between the elements considered. In this perspective, as we will see, the BCS model overcomes this limitation.

The basic cognitive schemes model.

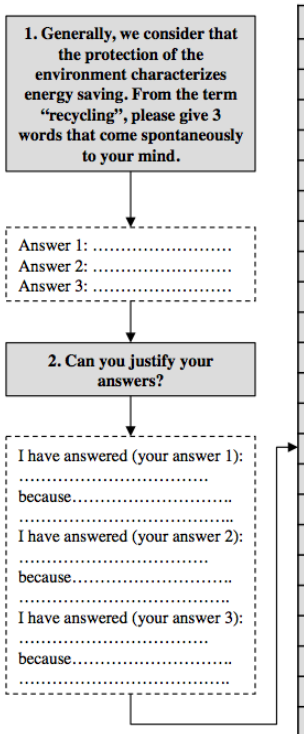
The method, or the questionnaire, of the Basic Cognitive Schemes (BCS) relies on the eponymous model, which is based on the connexity property of the elements of an SR. As noted above, although the similarity analysis focuses on quantitative connexity, it appears that the relationship between two elements can be described by several qualitative aspects. The

[1] Hubalek (1982) has inventoried more than 70 similarity indices.

[2] Several indices can be used in the framework of the similarity analysis (see Vergès & Bouriche, 2001).

BCS model formalizes these aspects through 28 connectors (see Figure 3) or types of relationship (Fraïssé & Stewart, 2002; Guimelli & Rouquette, 1992). For example, the element A may be synonymous with the element B or may be the opposite, the cause, or the result of B, etc. The 28 connectors are grouped into five sets, called "basic cognitive schemes" (Guimelli & Rouquette, 1992), which refer to different types of relationship: (a) *Lexicon*, (b) *Neighborhood*, (c) *Composition*, (d) *Praxis*, and (e) *Attribution*. The first three sets (lexicon, neighborhood and composition) can be grouped into a descriptive meta-scheme. In the final questionnaire, the two elements and the connector can take a verbal form, as for example A means the same thing as B (synonymy relationship; for all the verbal forms, see Fraïssé & Stewart, 2002).

This theoretical model is associated with an empirical method that is used to examine the structure of SRs (i.e., the core-periphery status of the elements). In practice, participants complete three steps (see Figure 3 for an example).



3.	Write here your answer 1:	YES	NO	Maybe
SYN:	"Recycling" means the same thing, has the same sense as your answer 1	☐	☐	☐
DEF:	"Recycling" can be defined as your answer 1	☐	☐	☐
ANT:	"Recycling" is the opposite of your answer 1	☐	☐	☐
TEG:	"Recycling" is a part of, is included in, is an example of your answer 1	☐	☐	☐
TES:	"Recycling" has for an example, for a particular case, comprises, includes your answer 1	☐	☐	☐
COL:	"Recycling" belongs to the same class, general category as your answer 1	☐	☐	☐
COM:	"Recycling" is a constituent, component of your answer 1	☐	☐	☐
DEC:	"Recycling" has as a component, as a constituent, your answer 1	☐	☐	☐
ART:	"Recycling" and your answer 1 are both constituents of the same thing	☐	☐	☐
OPE:	"Recycling" makes your answer 1	☐	☐	☐
TRA:	"Recycling" has an action on your answer 1	☐	☐	☐
UTI:	"Recycling" uses your answer 1	☐	☐	☐
ACT:	It is your answer 1 which makes "Recycling"	☐	☐	☐
OBJ:	"Recycling" is an action which has for object, carries on, applies to your answer 1	☐	☐	☐
UST:	To make "Recycling", we use your answer 1	☐	☐	☐
FAC:	Your answer 1 is someone (a person, an institution) who acts on "Recycling"	☐	☐	☐
MOD:	Your answer 1 indicates an action that we can make on (about, in case of, towards) "Recycling"	☐	☐	☐
AOB:	Your answer 1 is a tool that we use on (about, in case of, towards) "Recycling"	☐	☐	☐
TIL:	"Recycling" is used by your answer 1	☐	☐	☐
OUT:	We use "Recycling" to make your answer 1	☐	☐	☐
AOU:	"Recycling" is a tool which we can use to make your answer 1	☐	☐	☐
CAR:	"Recycling" is always characterized by your answer 1	☐	☐	☐
FRE:	"Recycling" is often characterized by your answer 1	☐	☐	☐
SPE:	"Recycling" is sometimes characterized by your answer 1	☐	☐	☐
NOR:	"Recycling" has to have the quality of your answer 1	☐	☐	☐
EVA:	Your answer 1 estimates "Recycling"	☐	☐	☐
COS:	"Recycling" results in (consequence or goal), entails your answer 1	☐	☐	☐
EFF:	"Recycling" has for cause, depends on, is entailed by your answer 1	☐	☐	☐

Figure 3. Example of the procedure used in the BCS model. Note that participants have to complete the table for each one of their answers on three different pages.

From raw data, different valences are calculated: total or partial valences reflect the overall versus the specific relationship between the inductor (A), which is, most of the time, an element linked to the object of representation under study, and the production (B, C, and D). The total valence reflects the overall connexity while partial valences reflect the salience of different types of connexity related to the different types of relationship (e.g., praxis, attribution, composition, etc.). In this way, the BCS model enables the identification of the nature of the elements composing the central core of an SR. For example, a high partial valence on praxis refers directly to the functional elements while a high partial valence on attribution means that the element is normative. High partial valences on both praxis and attribution characterize mixed elements (see Guimelli, 1998a, 2003).

In contrast to hierarchical evocations, the BCS model can be used in both cases, although a reliable diagnosis, even though it requires only one method, must be carried out twice (i.e., a first step to gather the content and a second one to achieve a structural diagnosis). Nevertheless, the issue for the SR and the structural approach, especially with regard to potential applications, is the availability of a methodology that gives information about both content and structure. Furthermore, the BCS model requires 84 responses per participant to test the structural status of an element. Thus, if the researcher wishes to diagnose the structural status of five elements, he/she needs to obtain 84 responses X five elements, i.e., 420 responses. However, according to Burchell and Marsh (1992), the length of a questionnaire is deleterious for the reliability of the responses provided by the participants. Moreover, according to these authors, it affects closed-ended questions more than open-ended ones, which constitute the BCS questionnaire.

As we have seen, the hierarchical evocations method and the questionnaire of characterization provide centrality hypotheses that need to be confirmed or not by means of a centrality test (Abric, 2003a). There are several ways to test these hypotheses; in addition to the BCS model, the Attribute-Challenge Technique (ACT) and the Test of Context Independence (TCI) are available. Given that some limitations are similar for these methodological options, we present them and then discuss their limitations in two steps: first, we discuss the limitations and potential solutions concerning both methods and, secondly, we present the specific limitations of the Test of Context Independence (TCI).

The Attribute-Challenge Technique (ACT)

The Attribute-Challenge Technique (ACT) was the first method to provide a systematic diagnosis of SR structure (Moliner, 1989, 2002). It is based on the symbolic property of the

core elements (i.e., assignment of meaning to the object of representation). These elements are essential or "non-negotiable" (Moscovici, 1993) to define the object. Without them, it loses its meaning and it is then impossible for individuals to recognize the object. Consequently, this technique tests the non-negotiable characteristics of the representational elements. Widely used, it has been considered the most effective way to reveal the structure of an SR (Flament, 2001). This technique is based on the double-negative principle and can determine whether the lack of a link between the representational element and the object of representation (first negation) is unacceptable (second negation) or acceptable (absence of second negation). If the absence of a link between the element and the object of representation proves to be unacceptable to the majority of participants, this means that this element is non-negotiable for the definition of the object and is therefore central. It may be operationalized by a questionnaire composed of the following kind of proposition: "In your opinion, can an activity be qualified as energy saving if it does not give rise to preserving the environment?".

Additionally, it should be noted that the Basic Cognitive Schemes model (BCS: Guimelli, 2003; Guimelli & Rouquette, 1992; Rouquette & Rateau, 1998, see below) allows a cross-validation of the ACT (Guimelli & Rateau, 2003). In the same way, the ACT was used very recently to validate the Test of Context Independence (TCI: Lo Monaco et al., 2008) thus avoiding the limitations related to the double negative used in the framework of the ACT and the fact that the ACT is not adapted to all types of object.

The Test of Context Independence (TCI)

Faced with the multiple constraints related to the various methods of structural diagnoses, Lo Monaco et al. (2008) proposed a method based on another property of the central elements: their insensitivity to the immediate context (Abric, 1993, 2001; Flament, 1995; Skandrani-Marzouki et al., 2015; Wagner et al., 1996). Thus, considering that a central element is "trans-

situational", it should be characteristic of the object of representation regardless of the situation. It is then possible to ask the subjects: "In your opinion, is "energy saving" an activity that always involves, in all cases, preserving the environment?". If most subjects respond affirmatively, the element may be considered central. Through their presentation of this method, Lo Monaco et al. (2008) were able to demonstrate that it provides the same results as the ACT, while representing a smaller perceived cognitive cost for the participants (see Figure 4 for an example of the procedure to follow for both the ACT and the TCI).

ACT : In your opinion, can an activity be considered as energy savings if it does not give rise to: **TCI :** In your opinion, is "energy savings" an activity that always involves, in all cases:	Examining the frequencies of "No" responses (ACT) or "Yes" responses (TCI)	
	ACT ("No" frequencies)	**TCI ("Yes" frequencies)**
Preserving natural resources	.80	.80
Preserving the environment	.79	.79
Economizing electricity	.65	.65
Recycling	.54	.54
Limiting pollution	.46	.46
Economizing heat	.72	.72
Renewable energies	.46	.46
A necessary action	.70	.70
Allows saving money	.50	.50
Using the car less	.67	.67
Economizing water	.65	.65
Preserving the future for the generations to come	.86	.86

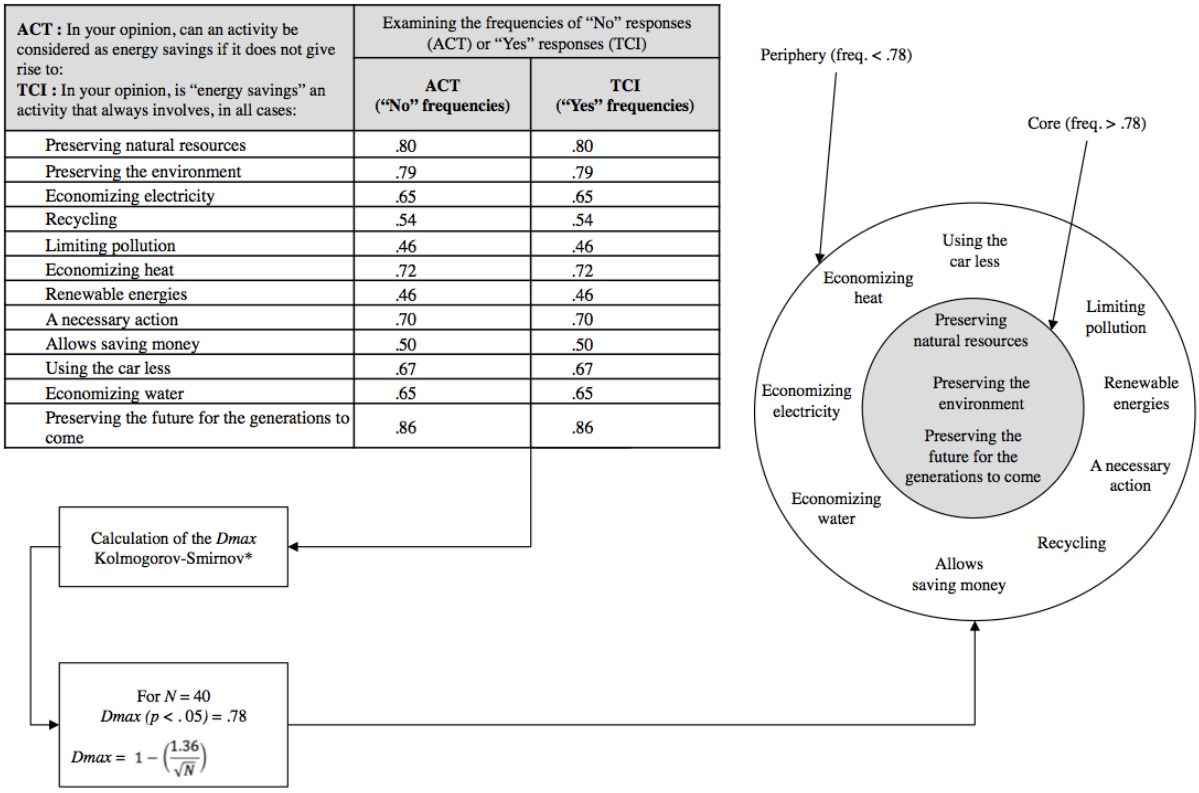


Figure 4. Fictitious example of the procedures of the ACT and TCI concerning the social representations of energy saving (adapted from the results obtained by Souchet & Girandola, 2013).

*See below for a presentation of the different indices

For the ACT, the TCI and the questionnaire of characterization, the major issue is the accuracy of the structural diagnosis. In fact, when we talk about hypotheses of centrality, we assume that some methods (e.g., prototypical analysis, similarity analysis, characterization or Q. Sort questionnaire) give access to an initial idea of the structure but this must be confirmed by the use of a more reliable method in terms of diagnosis.

The problem of the reliability of the diagnosis does not imply that some methods are obsolete because, despite this problem, they still have many advantages. Indeed, as mentioned above, SR studies conducted in the field often have constraints in terms of feasibility. In this perspective, the problems of structural diagnosis may not be decisive and may not rule out a method that ensures data collection in good conditions of understanding and timeliness. This problem of thresholds also affects the methods of systematic location of the structure. Concerning the decision thresholds to affirm the structural status of an item, three pieces of information are identifiable in the literature. An element may be considered central if the majority of participants reject or accept (for the ACT and TCI, respectively) the possibility of a lack or a presence (for the ACT and TCI, respectively) of a connection between the element and the object. However, according to Lo Monaco (2008, p. 52), "the idea of majority is obviously too relative to constitute a reliable reference for such an important issue." Thus, several solutions exist to "secure" a decision threshold.

Firstly, from the outset, "the arbitrary cutoff point" (Moliner, 2002, p. 277) of 75% was proposed and is still used in many studies (Flament, 1999). Secondly, some studies (e.g., Roussiau & Bonardi, 2001; Tafani & Souchet, 2002) used a norm of equi-frequency using the chi^2-test. This method of data analysis considers elements as central when the proportion of refutations differs significantly from a random distribution. In this framework, it is also possible to compare the frequency of negative responses (i.e., refutations) to the norm of 75% mentioned above. Finally, besides considering the ideal theoretical percentage of 100%

(Flament, 1999), which is rarely observed in practice, it is possible to use "in any theoretical rigor" (Moliner et al., 2002, p. 137), and from a radical point of view (Moliner, 2002), the Kolmogorov-Smirnov (KS) test (Abric, 2003b; Moliner, 2002; Moliner et al., 2002) whose principle is to calculate a threshold beyond which the proportion of refutations does not differ statistically from 100%. Unfortunately, none of these criteria is fully satisfactory. For example, using either the equi-frequency test or the KS test involves taking into account the sample size. In this case, the more the sample size increases, the more lax the equi-frequency test becomes and the more severe the KS test becomes. Even if the change in the threshold is large with regard to the number of participants, it still means that a simple simulation of the threshold of the KS for $N = 400$ may lead to a threshold equal to 0.93. Thus, any item with a refutation (i.e., in the context of the ACT) or recognition (i.e., in the context of the TCI) score lower than this threshold will be considered peripheral. Obviously, few studies have highlighted a central core composed of elements with such refutation/recognition scores. Consequently, the sample size becomes a new constraint directly imposed by the use of these methods and the application of these statistical indices.

In fact, the more the size of the sample increases, the more the variability decreases. According to the law of large numbers, the increase in the severity of the KS based on the increase in the size of the sample is theoretically valid (Well, Pollatsek, & Boyce, 1990). However, in the framework of the studies on SRs, the increase in the sample size increases the probability of surveyed individuals forming a subgroup with different positioning on the representational elements, and consequently mitigating the consensus assessment. The theory of large numbers assumes that an increase in the population will enable the parameter on the basis of which it was selected to be estimated better. Yet, in an SR study, the parameter in question is the relationship of the population with the object of representation (according to Abric, 1994, a group is characterized by a common representation). However, we have to

wonder about the meaning of the term "group" and its borders. In fact, the selection of a sample suggests a fundamental question, which would exceed the constraint of the size of the sample and its impact on the thresholds and their greater severity. Nevertheless, it seems difficult to impose or recommend a maximum size and one might ask on the basis of what criteria. As we will see in the discussion of the present article, it is necessary to think about the boundaries of the groups under study and what a "group" means in the framework of SR studies (Potter & Litton, 1985; Hogg & Abrams, 1990).

Otherwise, through recent studies focusing on the number of response modalities, authors have shown that there are variations in the diagnosis of centrality, in terms of the number of elements diagnosed as central, depending on whether an intermediate position is proposed or not (i.e., 4 modalities of response vs. 5 modalities of response, Apostolidis et al., 2011; Dany & Apostolidis, 2007). For the SR of studies in higher education, Dany and Apostolidis (2007) reported that there are three central elements with a scale consisting of 4 modalities of response and one central element with a scale consisting of five modalities. The authors question several aspects related to this difference in diagnosis. Among the interpretations formulated, they suggest that resorting to an intermediate position could be due to difficulties in understanding the formulations used in the ACT (Combs & Combs, 1976; Velez & Ashworth, 2007). This is caused by the use of a double-negative (Wolf, 2008) and is expressed by the participants when questioned on this topic (Lo Monaco et al., 2008). Nevertheless, taking into account earlier work and the stability of the diagnosis in several studies, the authors dismiss this interpretation. However, an experimental study could be conducted to compare the results obtained with 4 and 5 modalities with both the ACT and the TCI. In fact, given that the TCI leads to fewer difficulties for participants (Lo Monaco et al., 2008), if a difference persists, the problems of understanding could be ruled out with greater

certainty. In the reverse case, it would be necessary to admit that the difficulties in understanding are, in part, responsible for this observed difference.

Concerning specifically the TCI, current studies lack the benefit of enough hindsight. Nevertheless, although the TCI does not have problems in terms of understanding (Lo Monaco et al., 2008), it points out a limitation with regard to the modalities used in the scale. As a reminder, in the TCI, participants have to answer a question for each item such as: "In your opinion, is "studying in higher education", an activity that always allows, in all cases, the acquisition of knowledge?". In order to respond to this question, Lo Monaco et al. (2008) proposed the use of a 4-point scale (i.e., 1 = "definitely not"; 2 = "rather not"; 3 = "rather yes"; 4 = "definitely yes"). Although using these terms was perfectly consistent with those used in the ACT (because the authors wanted to get as close as possible to the ACT in order to provide a cross-validation with it), it is clear that they are quite inadequate for the question. Obviously, it is difficult to ask participants to assess a trans-situational link (i.e., "always, in all cases") and answer with a relative response (i.e., "rather yes" or "rather not"). Such a formulation of the question needs to be answered by a dichotomous choice modality (i.e., "yes" or "no"). An alternative would be to ask participants to assess the degree of "trans-situationality" between the element and the object. For example, they would answer, by means of a 7-point scale (ranging from 1 = "Never" to 7 = "Always"), the following question: "In your opinion, does an activity that corresponds to studying in higher education allow the acquisition of knowledge?". This research perspective needs to be empirically tested but seems to demonstrate a better logic between the wording of the question and the modalities of the response.

A Decision Tree

After having presented the different methodologies, their advantages, their limitations and the potential solutions that could be developed, we would like to offer the following decision tree (Figure 5) as a practical way to help researchers and practitioners.

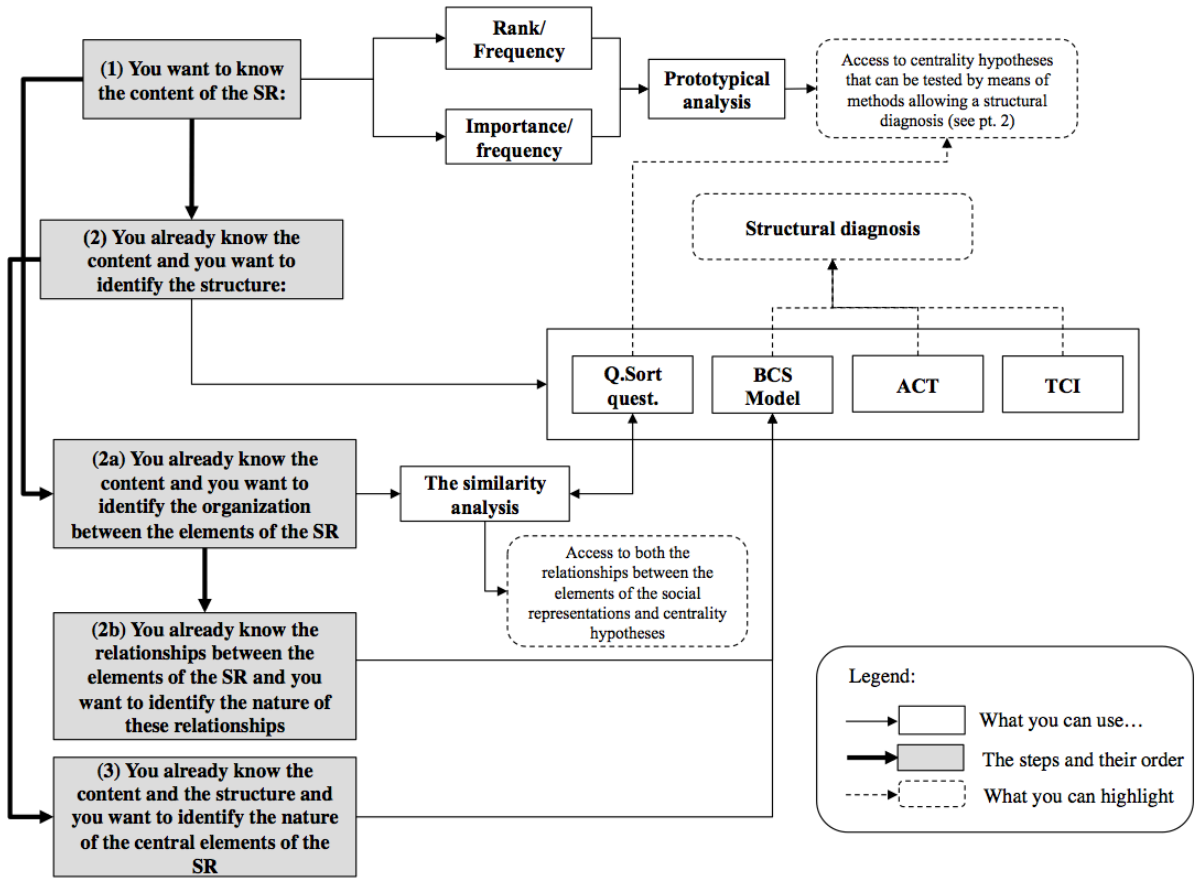


Figure 5. Decision tree to study the structure of social representations and the organization of the elements

Discussion and Conclusion

This article evaluates the methodologies used in the framework of the structural approach to SRs. More specifically, it describes and questions the advantages and limitations of each method presented. In addition, in order to overcome these limitations, suggestions are made for future research directions.

However, in our opinion, such a research program needs to be organized based on criteria referring to an order of priority. For example, a logical sequence can easily be imagined in which participants are first asked to associate words or phrases and, secondly, the centrality is controlled using the ACT, TCI or BCS model. As we have seen above, there are many problems regarding the grouping methods and identification of thresholds within each method but, in our opinion, tackling the beginning of the methodological sequence is the most urgent. Obviously, it is risky to conclude about the structure of the SR if, from the very beginning, the relevance of the grouping procedure concerning the themes related to the content (i.e., proposition of the semantic contextualization technique) is uncertain. In this context, it seems important that research should start to be interested in the issues related to the first phases in the SR research process. This does not mean that certain limitations are more important than others. It rather highlights the simple fact that as long as the questions raised about the early stages of investigation remain unanswered, there will be a greater risk of making mistakes later in the study.

Furthermore, this review points out that methodological research cannot stray from theoretical questions and principles (Di Giacomo, 1981). For example, the problems highlighted in terms of choice of thresholds refer to theoretical concerns such as consensus, level of consensus and, more specifically, its quantification. It is difficult to give a general rule as the notion of consensus is relative (Doise & Moscovici, 1992). Clearly, consensus must not be confused with the majority and, even when consensus is agreed, the idea of majority remains relative and inaccurate (Lo Monaco, 2008). In this context, it should be remembered that the use of the norm of equi-frequency shows that the number of participants observed for an item (e.g., in the MEC or the TCI) differs from that produced by random distribution. However, it remains sensitive to variations in terms of number of participants. In addition, even if the relevance of the use of the Kolmogorov-Smirnov Dmax test relating to

the law of large numbers can be demonstrated, the sticking point seems to be the sample size and thus the size of the interviewed group. Nevertheless, it seems rather limited to deal with this aspect only in terms of methodology. As we have stated above, methodological issues are interrelated with theoretical questions (Di Giacomo, 1981) and a return to the theory for an understanding of methodological aspects appears to be a necessary step.

The problem of the size of the interviewed group must be considered and echoes the remarks of Hogg and Abrams (1990), who took up the criticisms set out by Potter and Litton (1985), that the SR theory has never defined the group to which it refers. Moreover, through a discussion of three studies (Di Giacomo, 1981; Herzlich, 1973; Hewstone et al., 1982), Potter and Litton (1985) addressed four major criticisms, two of which are quite relevant to the problems of thresholds currently encountered in the study of the structure of SRs. The authors noted that the groups examined in the cited studies (and this is true for many studies in the field of SR theory) are not the object of a systematic reflection regarding their status as a group. For example, they found that the students surveyed by Di Giacomo (1981) were considered students without taking the precaution of checking their identification with the student group. However, when we ask the question about thresholds, it seems to us that before making our procedures more sophisticated, we should first check the problem at a theoretical level. Then, one should wonder about the limitations of the SR theory and its precision concerning the identification of the boundaries of the groups considered (Hogg & Abrams, 1990; Potter & Litton, 1985). Thus, in adopting this viewpoint, it seems appropriate to consider first the theory and then the method. The second note of Potter and Litton (1985), closely linked to the first, refers to the levels of consensus as they are seen in the SR field of research. To construct an SR and to defend a vision of reality in the context of intergroup relations involving polemical, mutually exclusive representations (Licata, Klein, & Gély, 2007; Lo Monaco & Guimelli, 2011; Moscovici, 1988), a common vision of the object is

necessary, to the extent that it constitutes the matrix of the reference group and thus ensures an identity function in the definition of the ingroup (sharing) and the outgroup (opposition). In our view, considering the level of identification, this demarcation of the group boundaries constitutes a prerequisite for experimental and field studies. Therefore, taking into account social identification with the reference group would reveal borders with the greatest accuracy. Indeed, "satisfying an index of membership, however objective, does not entail that the individual will identify with, or act in terms of, the specified group" (Potter & Litton, 1985, p. 83).

In line with this viewpoint, one can refer to Turner (1991) who establishes a clear distinction between membership group and reference group on the basis of the social identification criterion. Needless to say, these results related to the criticisms made by Potter and Litton (1985) and Hogg and Abrams (1990) reveal the challenge that exists around the issue of the demarcation of the boundaries of the interviewed groups. Furthermore, the issue of social identification leads to considering high identifiers as thinking and behaving according to the group prototype. Thus, from this aspect, a link can be found between social representations and identity approaches. In fact, considering Breakwell's theoretical proposals (1993) or those of Deschamps and Moliner (2008), or the works carried out, for example, by Breakwell (2001), Howarth (2006), Hewstone et al. (1982), Moliner, Lorenzi-Cioldi and Vinet (2009), Moliner and Vinet (2006), Rateau (2004), Tafani and Deschamps (2004) or more recently Zouhri and Rateau (2015), researchers have begun to tackle the question of a conceptual link sustained in an empirical way. Yet, according to Moscovici (1981), the SR enables the reduction of uncertainty and this is facilitated by the fact that the consensus is located at the level of the social group. However, SR theory has provided no definition of the group, has not specified the group to which it refers and, more precisely, has not indicated the boundaries of these groups or the criteria to take into account to consider that there is a group

relative to a given object. Yet, Terry and Hogg (1996), referring to the Referent Informational Influence Model or the uncertainty reduction theory (e.g., Hogg 2000; Hogg & Abrams, 1993), indicated that individuals identify with the group and shared norms in order to reduce uncertainty and appease the tension linked to the latter. This perspective is echoed in the SR theory because, by dealing with information relating to a given object through communication, individuals will be able to compare opinions and obtain new information (Moscovici, 1961, 2008; Rouquette, 1998). It seems relevant to consider that the information discussed by the highly identified members directly concerned by the object can reduce their uncertainty. Thus, the group would provide an adapted way to think about the object. Therefore, identification with the reference group can play a fundamental role in the social construction of the object. Including social identification in the diagnosis of the structure of an SR would become an interesting factor since it would be involved in the convergence of the members of the group with regard to their way of thinking about the object and thus in the structuring of the representation. This aspect would be very important, for example, in research on the "*SR Structure Effect*" (Skandrani-Marzouki et al., 2015) in the context of cognitive processes related to social influence (e.g., Mugny et al., 2008), attitude change (e.g., Tafani & Souchet, 2002), social comparison (Chokier & Rateau, 2009), behavioral commitment (e.g., Piermattéo, Lo Monaco, & Girandola, 2015; Souchet & Girandola, 2013; for a recent review, see Lo Monaco et al., in press) or in research linking the structure of social representations to emotions (e.g., Skandrani-Marzouki et al., 2015). Thus, these investigations require prior identification of the structure of the SR. Future research may need to strengthen these essential theoretical links between the SR theory and identity approaches in order to provide information that will lead to methodological solutions.

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