

**UNIVERSITE DE DROIT, D'ECONOMIE ET DES SCIENCES D'AIX MARSEILLE
UNIVERSITE PAUL CEZANNE
INSTITUT D'ADMINISTRATION DES ENTREPRISES**

**CENTRE D'ETUDES ET DE RECHERCHE
EN GESTION D'AIX MARSEILLE**

**EXPLORING ABSORPTIVE CAPACITY :
HOW OPERATIONALIZATION LEAD TO
A DYNAMIC OUTLOOK OF THE CONCEPT**

*Vincent CHAUVET**

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Institut d'Administration des Entreprises, Clos Guiot, Puyricard, CS 30063
13089 Aix-en-Provence Cedex 2, France
Tel. : 04 42 28 08 08.- Fax : 04 42 28 08 00

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Institut d'Administration des Entreprises, Clos Guiot, 13540 Puyricard, France
Tel. : 04 42 28 08 08.- Fax : 04 42 28 08 00

L'exploration de la capacité d'absorption : comment l'opérationnalisation mène à une perspective dynamique du concept

Résumé

Le but de cet article est d'analyser en profondeur le concept de capacité d'absorption à travers une approche individuelle. Cette perspective novatrice permet de mettre en évidence une nouvelle conceptualisation de la capacité d'absorption que nous considérons comme une chaîne séquentielle de processus d'apprentissage encastrés.

Mots clés

Capacité d'absorption, apprentissage organisationnel, innovation.

Exploring absorptive capacity: how operationalization lead to a dynamic outlook of the concept

Abstract

The goal of this paper is to analyze in depth the concept of absorptive capacity, through an individual approach. This innovative perspective highlights a new conceptualization of ACAP as a time-sequenced chain of embedded learning processes.

Key words

Absorptive capacity, organizational learning, innovation.

INTRODUCTION

Both in academic and industrial fields, knowledge is now recognized as one of the most valuable resources for firms' development and competitiveness. The Knowledge Based-View (KBV) points out that strategic advantage depends on how the firm is able to acquire and exploit knowledge (Spender, 1996). "Firms are increasingly relying on knowledge acquired from other firms to facilitate the development of their own capabilities" (Lane and Lubatkin, 1998, p. 473). As a consequence, the importance of Absorptive CAPacity (ACAP) keeps on growing since the first paper of Cohen and Levinthal (1990), who defined it as the ability of a firm to value and recognize new external knowledge, assimilate it and apply it. Whereas this definition meets a global consensus in the numerous researches using this concept (Lane, Koka and Pathak, 2006, p. 842), it is important to note that ACAP was used in diverse settings, conceptualized in multiple ways and measured with very different scales. But it has always been considered as a source of sustainable competitive advantage (Cohen and Levinthal, 1990; Cockburn and Henderson, 1998; Eisenhart and Martin, 2000; Zahra and George, 2002) through innovation (Tsai, 2001; Jansen and al., 2005), interorganizational learning (Lane and Lubatkin, 1998) and knowledge transfer (Szulanski, 1996; Gupta and Govindarajan, 2000). This ambiguous situation has lead to new theoretical papers on ACAP proposing a reconceptualization (Zahra and George, 2002), a rejuvenation of the construct (Lane, Koka and Pathak, 2006) or again a new reconceptualization (Todorova and Durisin, 2007).

Whereas this interest toward ACAP is not new, current knowledge about this domain needs more clarity. A major weakness highlighted by recent papers (Lane and al., 2006; Todorova and Durisin, 2007) lies in the fact that authors did not take advantage of past research. One of the main reasons is the complexity to operationalize absorptive capacity, except by using proxy variables as R&D intensity for instance. This complexity to establish a pattern of ACAP resides first in the fact that some papers refer to the three dimensions of Cohen and Levinthal (1990) and others to the four dimensions highlighted by Zahra and Gerorge (2002). Moreover, gathering these dimensions in a single concept or in a two-dimension one, referring to Zahra and George (2002) Potential (PACAP) and Realized Absorptive Capacity (RACAP), without sacrificing the power of explanation of each step, is not easy. However, the need for a critical review and empirical test constitutes one of the major research issues for ACAP research nowadays.

Therefore, the goal of this paper is to build a scale of absorptive capacity taking into consideration past theoretical and empirical research mobilizing this concept. One of the main issues is that past research has failed to see ACAP as a multilevel variable. In this perspective, we propose to approach ACAP through an individual perspective based on the idea that “an organization’s absorptive capacity will depend on the absorptive capacities of its individual members” (Cohen and Levinthal, 1990, p. 131). First, we build on previous papers to determine precisely the scope of each dimension. Second, we do not use the conceptual (Zahra and George, 2002) and recent empirical (Jansen and al., 2005) distinction proposed with PACAP and RACAP. Even if this refinement makes sense, we prefer to consider each ACAP dimension separately, as a time-sequenced chain of learning processes that could take place at different level of analysis (individual, unit and organization). Third, we propose a new conceptualization of ACAP as a sum of different and complementary dynamic capabilities, that enable a firm to reconfigure its knowledge base and to adapt to changing environmental conditions.

LITERATURE REVIEW ON ABSORPTIVE CAPACITY

Many researchers in different fields (industrial economics, organizational learning, RBV, dynamic capabilities, innovation...) mobilized ACAP in order to explain organizational phenomena and performance. The main problem in using this concept remains in the very different approaches used by academics. Nearly all ACAP papers refer to Cohen and Levinthal (1990) but they do not extensively use past research to build on it. Lane and al. (2006) indicate that 52% of the articles on ACAP have not been cited by any other paper. Building on past research, we point out that the main differences in ACAP development resides in three major elements that strengthen the complexity of the concept: level of analysis (1), operationalization (2) and dimensionality (3). Through a deep literature review we first define ACAP, and then we try to clarify our approach in discussing the three issues mentioned above.

Definition

Past research highlights a consensus in the definition of absorptive capacity, and also concerning its roles and outcomes. Cohen and Levinthal’s (1990) definition of absorptive capacity is the first and the more recognized one. They define it as “the ability to value new

external information, to assimilate it and to apply it to commercial ends” (p. 128). Thus, absorptive capacity is composed of three dimensions.

In 2002, Zahra and George proposed a reconceptualization of ACAP. They define it “as a set of organizational routines and processes by which firms acquire, assimilate, transform and exploit knowledge to produce a dynamic organizational capability” (p. 186). While keeping a great part of the original definition, they depart from past research in two elements. First, they identify a fourth dimension, transformation, between the assimilation and exploitation phases. Second, they stress the importance of these dimensions considering them as dynamic capabilities that are combinative.

At last, Lane and al. (2006) define ACAP as “a firm’s ability to utilize externally held knowledge through three sequential processes: (1) recognizing and understanding potentially valuable new knowledge outside the firm through exploratory learning, (2) assimilating valuable new knowledge through transformative learning, and (3) using the assimilated knowledge to create new knowledge and commercial outputs through exploitative learning” (p. 856). In this definition, they mainly refer to Cohen and Levinthal (1990) but borrow the dynamic capabilities perspective from Zahra and George (2002).

These three definitions are very close together in the way that the two last are clearly built on Cohen and Levinthal’s (1990) one. However, we do not strictly follow one of these for two reasons. First, we believe that the transformation step, between assimilation and exploitation, is interesting because it strengthens the dynamic capabilities perspective through the integration of organizational learning mechanisms based partly on transformative learning (Lane and al., 2006; Todorova and Durisin, 2007). Cohen and Levinthal (1990) and Todorova and Durisin (2007) definitions do not really consider this dimension. Second, Zahra and George’s (2002) definition does not take into account the capacity to recognize and value new external information which seem to be a critical activity in external knowledge acquisition (Henderson and Clark, 1990), while Cohen and Levinthal and Todorova and Durisin clearly point out this aspect in the first dimension.

Therefore, we keep for the time being the original definition of Cohen and Levinthal (1990) while introducing the third dimension (transformation) highlighted by Zahra and George (2002). After an operationalization of ACAP, a new definition is proposed and discussed at

the end of the paper. Before the description of each dimension in this research, three shortcomings relative to ACAP research are discussed.

Critics about ACAP research

The objective of this part is to clarify our approach of ACAP taking into consideration the main shortcomings in the study of this concept. The structure of the literature review, that includes the most central papers in ACAP literature (Zahra and George, 2002; Lane and al., 2006), is designed to get all the aspects of this concept in a progressive way. First, problems concerning level of analysis are approached. Second, operationalization is addressed leading to the description of ACAP dimensions in previous studies. Third, the dimensionality of the concept is discussed through two main points: the presentation in appendix 1 of the major theoretical and empirical papers on ACAP regarding the unit of analysis, theoretical lens, modeling, measurement and outcomes, and the division of ACAP in two subsets of Potential Absorptive Capacity (PACAP) and Realized Absorptive Capacity (RACAP).

Level of analysis

Cohen and Levinthal (1990) considered ACAP as an organizational level construct residing in firms and also in organizational units. Among these authors, absorptive capacity depends on the level of prior related knowledge of the firm, and it evolves “in a history-dependent fashion as the firm accumulated (or failed to accumulate) knowledge critical to its later growth” (Autio and al., 2000, p. 911) If we take a closer look to appendix 1, three units of analysis have been used in ACAP research: country, interorganization and organization. However, a great majority of papers use ACAP as an organizational level variable This approach does not allow to take into account the richness of the different ACAP components symbolized partly by the embeddedness of multiple levels of analysis. Indeed, past research has failed to see ACAP as a multilevel variable.

While Cohen and Levinthal (1990) argue that organizational absorptive capacity is a function of individuals absorptive capacity, no research has been realized at the individual level of analysis which is really surprising. This tendency is also highlighted by Lane and al. (2006): “The lack of attention to the process aspects of absorptive capacity has also led researchers to overlook the role of individuals in developing, deploying, and maintaining absorptive capacity” (p. 853). Indeed, a firm’s absorptive capacity reflects both the implications of individuals in managing and transferring knowledge, in using some processes and tools and

also in integrating the specificities of an industry. Furthermore, Dyer and Singh (1998) indicated that knowledge sharing routines constitute a critical mechanism in ACAP development relying on individuals' actions. While the organizational learning literature is often based on the study of individuals' actions and mechanisms, there was no influence on ACAP research. This aspect is called to change as Lane and al. (2006) suggest: "individual cognition is a critical internal driver of absorptive capacity" (p. 857). As a consequence, we approach ACAP from an individual perspective in this research for three reasons. First, the development of ACAP relies on the knowledge capabilities of individuals. This perspective gathers an individual and a collective dimension. Indeed, knowledge capabilities reflect both the capacities of individuals to acquire, assimilate, transform and exploit knowledge but also the organizational routines associated with knowledge sharing processes and information flows. Second, the complexity and ambiguity of the concept has led to a misuse with few generalizable results. Third, the creation of high-value products and services is dependent on the creativity of individuals. "It is the firm's individual members who add the creativity needed to help the firm uniquely create value from new knowledge" (Lane and al., 2006, p. 854). Thus, using an individual level of analysis to deepen our knowledge concerning ACAP seems relevant.

Operationalization

The main problem concerning ACAP studies lies in its operationalization. While we nearly reach twenty years of absorptive capacity research, few papers try to operationalize it except with objective variables. Indeed, ACAP was often measured with proxies like R&D intensity, patents, number of scientists working in R&D departments, number of publications, number of new projects, development length of a new product/service... As Lane et al. (2006, pp. 854) argue "most studies have operationalized ACAP with R&D-related proxies, such as R&D intensity or patents [...] leading us to question whether these studies actually measured absorptive capacity at all". In our view, these objective measures of ACAP have six main shortcomings:

- First, proxy measures of ACAP have a weak explicative power regarding to the strength one of its dimensions. Indeed, the concept of absorptive capacity is much more than just R&D intensity or number of patents. These kinds of measures were often used because such R&D or patent data are quite easy to obtain, but they "have been rudimentary and do not fully reflect the richness of the construct" (Zahra and George, 2002, p. 199).

- Second, if we consider ACAP as a dynamic capability, as Zahra and George (2002) argue, using such objective measures is totally inadequate. R&D intensity or number of patents display a static view of absorptive capacity. They do not take into account all the knowledge processes and flows inside and outside the organization, nor the classical path of knowledge development.
- Third, these measures neglect the role of individuals in organizations although Cohen and Levinthal (1990) highlighted the sociocognitive aspects and processes of this concept. Indeed, innovation or new product development perspectives rely mainly on the capabilities of individuals. Thus, taking into consideration the role of individuals in knowledge activities appears fundamental for ACAP operationalization.
- Fourth, proxy measures related to knowledge creation, as R&D intensity or patents for instance, have some accuracy problems according to Spender and Grant (1996). They argue that patents can better reflect a strategic positioning more than a real innovation.
- Fifth, if we take a look to prior research on ACAP, it appears that some results are not consistent. Some papers argue that ACAP (R&D intensity) is a predictor of interorganizational learning whereas others not (Mowery and al., 1996; Tsai, 2001). Thus, the adequacy and validity of proxy measures for ACAP are really questionable.
- Sixth, considering the context of this research, two aspects confirm the inadequacy of proxy measures. From one hand, there is not always a R&D department in SME's. Therefore, costs allocated to research activities are difficult to assess. From the other hand, several managers told us that patent registration is too expensive and time-consuming for their organizations.

For these reasons, we argue that the use of proxy measures for ACAP operationalization is not appropriate. The few research (Szulanski, 1996; Lane & Lubatkin, 1998; Jansen and al., 2005) that applied other kinds of variables for ACAP, as knowledge sharing mechanisms, organizational routines, capacities, dominant logic or compensation policies show that such factors explain more variance than R&D intensity. This issue emphasizes the richness and complexity of ACAP, that have to be recorded in its operationalization.

Taking into consideration both Cohen and Levinthal's consideration that individual cognitions are the basis of a firm's absorptive capacity and Lane and al., (2006) limiting assumptions in current ACAP research, we decide to display an individual approach of ACAP. This perspective allows to bypass several shortcomings of past research that are discussed in next

sections. Our objective is to emphasize the role of individuals in the development of absorptive capacity through the use of some organizational learning mechanisms. This approach is based on three main reasons. First, individuals are at the basis of learning theories and they are responsible for the identification, diffusion, development, transformation and exploitation of knowledge assets. Second, academics emphasize the role of ACAP in promoting innovation (Appendix 1). This perspective cannot be explored only through an organizational lens. Indeed, the innovative power of ACAP is contingent upon individuals' creativity and dynamic capacities. Employees bring knowledge within the firm and create unique value from that knowledge through their competence and experience in knowledge activities. "This uniqueness arises from the personal knowledge and mental models of the individuals within the firm, who scan the knowledge environment, bring the knowledge into the firm, and exploit the knowledge in products, processes, and services" (Lane and al., 2006, p. 854). Third, ACAP is definitely a multi-level construct that can be approached through an individual, a unit, an organizational or even an interorganizational perspective. However, if the goal is to make a deep analysis of ACAP functioning and development within a firm, taking into consideration both dynamic aspects and the role of social integration mechanisms, the individual level of analysis is, according to us, the more pertinent.

Before introducing the problems related to ACAP dimensionality, we present the content of the four dimensions based on past research that mobilize this concept.

Dimensions of ACAP

Table 1 displays the four ACAP dimensions relating it to its components, themes and main authors.

Table 1: composition of ACAP dimensions in previous research

Dimensions	Components	Themes & measures	Main authors
Acquisition	Prior knowledge	Knowledge repositories Experience of R&D service Last diploma	Dyer (1996); Szulanski (1996); Autio & al., (2000); Van Wijk & al. (2001); Zahra & George (2002)
	Prior investments	Risk tolerance CEO support R&D investment	Cohen & Levinthal (1990); Mowery & al., (1996); Kim (1998); Lahti & Beyerlein (2000); Zahra & George (2002)

	Motivation to acquire and share knowledge	Recognizing the value Commitment Intensity and speed	Cohen and Levinthal (1990); Zahra & George (2002); Mahnke & al., (2003); Lane & al. (2006); Todorova & Durisin (2007)
Assimilation	Knowledge understanding	Interpretation Comprehension Formalization	Cohen & Levinthal (1990); Dodgson (1993); Szulanski (1996); Lane & Lubatkin (1998); Jansen & al. (2005); Todorova & Durisin (2007)
Transformation	Knowledge conversion & internalization	Recodification Questioning Integration	Szulanski (1996); Kim (1998); Gruenfeld & al. (2000); Jansen & al. (2005); Todorova & Durisin (2007)
Exploitation	Knowledge use & implementation	Knowledge intensity Harvesting resources Core competencies	Cohen & Levinthal (1990); Dodgson (1993); Lane & Lubatkin (1998); Autio & al. (2000); Lane & al. (2006)

As we follow both a dynamic and individual approach, the literature on organizational learning was explored to build each of the four dimensions of ACAP. Thus, several knowledge processes and routines were used that put under consideration the numerous interactions between individuals. This aspect clearly supports a dynamic view of ACAP. “Critical to the advancement of the absorptive capacity literature is the need to move away from a structural perspective of absorptive capacity to a view of it as more of a dynamic capability. Such a shift in perspective focuses attention on the structure, policies, and processes within the organization that affect knowledge transfer, sharing, integration, and creation” (Lane and al., 2006, p. 857). Accordingly, the development of ACAP depends on the ability and motivation of firms’ members to share, integrate and exploit new external knowledge (Szulanski, 1996; Lane and Lubatkin, 1998; Lane, Salk, and Lyles, 2001; Zahra and George, 2002). Considering ACAP as a set of dynamic capabilities, knowledge-based mechanisms are used to operationalize each dimension at an individual level of analysis, which clearly lead to a processual analysis of absorptive capacity.

Acquisition

This process refers to the Cohen and Levinthal’s one in recognizing and valuing new external knowledge. It deals with three main components - prior investments, prior knowledge, commitment to gather knowledge – as shown in table 1 above (Zahra and George, 2002). Prior investments deal with the efforts of a firm to encourage knowledge acquisition and

transfer. Prior knowledge is considered as the level of expertise of the firm. “The ability to evaluate and utilize outside knowledge is largely a function of the level of prior related knowledge. [...] Prior knowledge confers an ability to recognize the value of new information, to assimilate it, and to apply it to commercial ends” (Cohen and Levinthal, 1990; Dyer and Singh, 1998). Commitment to gather knowledge determines the motivation of firms’ members in identifying and acquiring knowledge. As we adopt an individual approach of ACAP, it is important to note that a rich social context improves the communication between individuals (Verona, 1999) through the creation of closed relationships (Tsai and Ghoshal, 1998; Hansen, 1999) and enhance a unit’s ability to acquire, assimilate and exploit external knowledge (Jansen and al., 2005). Moreover, Cohen and Levinthal (1990) indicate that “an organization’s absorptive capacity does not simply depend on the organization’s direct interface with the external environment. It also depends on transfers of knowledge across and within subunits” (Cohen and Levinthal, 1990, p. 131). This perspective sheds light on the external and internal aspect of the acquisition dimension. From one hand, new knowledge can be acquired through interactions with external units. From the other hand, new knowledge can be acquired through internal interactions with firm members. This aspect has two main consequences. First, it clearly makes more complex the construction of a knowledge acquisition variable in gathering the three sub-dimensions indicated before. Second, this consideration underlines the fact that acquisition can be considered as the first step to develop a new knowledge basis within the firm. Thus, at an individual level of analysis, we suggest that knowledge identification and acquisition depends on the degree of knowledge access and flow.

This perspective emphasizes the role of knowledge transfers inside and outside the company. Szulanski (1996), studying transfers of best practices, highlighted the fact that a lack of absorptive capacity constituted a barrier to internal knowledge transfer. Moreover, Dyer and Singh (1998) pointed out that the development of ACAP is dependent on knowledge sharing routines inside and outside the firm. Building on this two results, a great part of external knowledge acquisition can be considered as a process based on knowledge sharing. A strong intensity of knowledge flows within and between firms constitutes a clear support to external knowledge acquisition. If firm members are acquainted about organizational and environmental changes, it suggests a dynamic process of knowledge acquisition based on individuals interactions.

Assimilation

“Assimilation refers to the firm’s routines and processes that allow it to analyze, process, interpret and understand information obtained from external sources” (Zahra and George, 2002, p. 189). This second dimension of absorptive capacity deals with individuals’ knowledge interpretation and understanding. This phase of absorptive capacity is far more individual than collective. Indeed, knowledge assimilation describes the capacity to understand new external knowledge and to link these new pieces to the existing knowledge basis. In this perspective, a scale of assimilation should measure the capacity of individuals to learn and understand new knowledge, and also to put into question existing processes, ways of doing or products and services.

Transformation

Transformation is the internalization of new external knowledge in existing firms’ processes and products. “Transformation denotes a firm’s capability to develop and refine the routines that facilitate combining existing knowledge and the newly acquired and assimilated knowledge” (Zahra and George, 2002, p. 190). In opposition to Todorova and Durisin (2007), we do not believe that “transformation represents an alternative process to assimilation” (p. 778) for three main reasons. First, transformation highlights the process of knowledge creation which is a fundamental step before exploitation. Second, knowledge transformation is not individual. It is a collective activity directed towards improvement perspectives based on individuals’ interactions and complementarity. This phase is important because it constitutes a strong link between assimilation and exploitation. Third, this step is relevant at an individual level of analysis because it links ACAP research with organizational learning literature (Lane and al., 2006).

Exploitation

This phase has often been considered as the most important one. If we look at Cohen and Levinthal’s definition, employees must be able to apply new external knowledge to commercial ends. “Exploitation as an organizational capability is based on the routines that allow firms to refine, extend, and leverage existing competencies or to create new ones by incorporating acquired and transformed knowledge into its operations” (Zahra and George, 2002, p. 190). Routines that allow the implementation of new knowledge into products or services are very precious ones (Spender, 1996). In this perspective, exploitation should not be neglected because it brings all the outcomes of knowledge identification, capitalization and

integration efforts. Previous scales of ACAP particularly focus on this dimension, using objective metrics as patents number or the launch of new products or services. Moreover, they do not take into consideration the importance of some routines in knowledge exploitation.

Dimensionality

As we already noted, Cohen and Levinthal (1990) suggested that ACAP has three dimensions: the ability to recognize and value new external knowledge, the ability to assimilate it and the ability to commercialize it, which can be resumed by acquisition, assimilation and exploitation. Whereas many authors refer to Cohen and Levinthal's paper, few of them display these three dimensions in their research (Lane and al., 2006). Indeed, they do not take into account the richness of the construct by only operationalizing ACAP through proxies measures as R&D intensity for instance. This point is developed in a further section. As a result, no papers really consider the dimensionality of the concept before Lane, Salk and Lyles in 2001. They were the first to destructure the unity in absorptive capacity in indicating that "the first two components, the ability to understand external knowledge and the ability to assimilate it, are interdependent yet distinct from the third component, the ability to apply the knowledge" (p.1156). This proposition was really pertinent in moving forward a deep exploration of ACAP dimensions.

In 2002, Zahra and George introduced a fourth dimension to ACAP with transformation that takes place between assimilation and exploitation steps. This new dimension is said to help the combination of newly acquired knowledge with in-house knowledge. The integration of this dimension presents three advantages. First, it helps to introduce some organizational learning mechanisms in ACAP development. Second, it makes a clear differentiation between diverse knowledge activities that could not be gathered in the same dimension. Third, it highlights a dynamic capabilities perspective. But Zahra and George (2002) go further the introduction of a fourth dimension. They more globally reconceptualize ACAP in differentiating two subsets: Potential Absorptive Capacity (PACAP) and Realized Absorptive Capacity (RACAP). PACAP is the ability of the firm to acquire and assimilate new external knowledge, and RACAP the ability to transform and exploit it. With this contribution, Zahra and George (2002) want to highlight both the complementarity between PACAP and RACAP, but also the different roles of each subset in profit generation. These authors indicate that firms differ in their approach of ACAP whether they focus on exploration (PACAP) or exploitation (RACAP) perspective. In their view, firms concentrating on PACAP are able to

renew their knowledge basis but they face problems that prevent exploitation benefits, mainly due to the costs dedicated to this exploration. In the opposite, firms concentrating on RACAP may generate short-term benefits but would not be able to bring new ideas into the firm. Therefore, “firms need to manage these dimensions of absorptive capacity successfully to obtain superior performance” (Jansen and al., 2005, p. 999).

However, Zahra and George (2002) stressed that “profits are created primarily through RACAP” (p. 191), which suggest a kind of hierarchy between the dimensions. Even if this consideration is quite logical from a practical point of view, it totally reduces the influence of knowledge acquisition and assimilation mechanisms in firm performance. In our view, this perspective has to be put into question for several reasons. First, if we consider ACAP as a set of dynamic capabilities as Zahra and George (2002) quoted, it is not relevant to consider that only RACAP generate profits. Indeed, this dynamic view of ACAP highlights a kind of sequence of organizational learning routines and mechanisms, each step building on the previous one, acquisition being the first activity to bring value into the firm. Second, RACAP is totally dependent on PACAP performance and it does not exist without knowledge identification and capitalization efforts. In that way, we could even consider that ACAP development is more relying on exploratory activities which is consistent with Cohen and Levinthal (1990) or Lane and Lubatkin (1998). Third, these four dimensions represent very different learning activities as shown in table 1. Acquisition is based on relational exchanges as knowledge sharing. Assimilation is a deep individual activity of knowledge internalization. Transformation can be described as a set of organizational mechanisms in order to link in-house with newly acquired knowledge, which suggests several collective aspects. Exploitation describes the unit capacity to value its products and services in the market.

For these reasons, we consider that the PACAP / RACAP categorization is not relevant from a theoretical perspective. Thus, we think that ACAP dimensions should be approached separately in order to take into consideration the richness of each step. This point is in line with Lane and al. (2006): “We believe that explicitly separating them is necessary, because each of these dimensions requires different processes within the organization. Explicitly separating the dimensions forces researchers to recognize the different nature of the processes underlying these constructs, as well as the interrelationships among them” (Lane and al., 2006, p. 857).

Two recent researches also put into question this potential and realized absorptive capacity conceptualization.

First, the empirical research of Jansen and al. (2005) indicated that “the four dimensions underlying potential and realized absorptive capacity ‘are’ not only theoretically, but also empirically distinguishable” (p. 1005). They show that a four-factor model of ACAP is better than the classical two-factor model with PACAP and RACAP. This contribution is central to the question of dimensionality of absorptive capacity.

Second, Todorova and Durisin (2007) presented a refined model of ACAP where transformation is no more a dimension of the concept. “We suggest that transformation is regarded not as a consequence but as an alternative process to assimilation” (p. 778). This proposition is based on the fact that knowledge assimilation is not always reached after acquisition. Consequently, firms must change their cognitive structures before assimilation, which allows to internalize new acquired knowledge that is incompatible with prior knowledge. This reflection is really interesting in considering some backward and forward loops between assimilation and transformation processes, highlighting therein a dynamic relation between these two dimensions. However, we believe that this proposition has two main problems. First, it does not really take into account the content of each dimension. As we already noticed, assimilation and transformation represent very different knowledge activities: assimilation is focused on knowledge internalization while the goal of transformation is to link prior knowledge with new acquired knowledge. Moreover, these two dimensions are also different in substance, assimilation being an individual activity while transformation being a more collective one. Second, we believe that Todorova and Durisin’s (2007) proposition is incomplete. While we agree with the authors in integrating some loops in ACAP development, we believe that some can also exist between others dimensions of absorptive capacity, as acquisition and assimilation for instance. Indeed, when they indicate that transformation can be alternative to assimilation based on cognitive structure changes issues, they do not take into consideration the role of individuals in knowledge assimilation. If newly acquired knowledge is too far from in-house knowledge and prevent its transformation, individuals have also the possibility to get back to the knowledge source, that is to say to acquisition, in order to clarify some ambiguous aspects. Thus, knowledge assimilation can be realized through transformative learning but also through a backmove to the knowledge source. In this perspective, we do not follow Todorova and Durisin (2007) who gather assimilation and transformation. As a conclusion, we consider in this paper that ACAP is

composed of four distinct and complementary dimensions (acquisition, assimilation, transformation and exploitation) that represent a dynamic model of organizational learning.

RESEARCH METHODOLOGY

Sample

French high-tech SME's were chosen to participate in this study. The selection process mainly resides in the use of criteria that measure the technological performance of firms. In this perspective, some indicators used by the OECD were identified. Four elements were used in this research to determine the "degree" of technology of firms, that is its technological performance: R&D investment, sales per employee, sales growth and patents. Thus, among 19 firms, 10 were kept accounting for their adequation with the technological performance criteria. These SME's are in different industries: automatic, robotic, electronic, computer and telecommunications.

Data collection

A first exploratory research concerning the mechanisms for promoting organizational learning was initiated by regional institutions and associations, interested in the development of high-tech SME's. This study allows to clarify our approach of absorptive capacity in the context of small companies. In this perspective, we decided to follow Van den Bosch and al. (2002) recommendations who suggested to distribute questionnaires to all the employees of the sample. Thanks to the support of top management, this research benefits from very good survey conditions in the way that we had a total access to the whole staff of the 10 firms. Thus, all the employees completed and returned the questionnaire. 246 were collected, 36 being not usable (too many missing values), for a total of 210 valid questionnaires. Confidentiality was ensured by asking employees to directly send us the questionnaire by mail or email, instead of dispatching it through company headquarters.

Validation of constructs

Few studies try to operationalize ACAP except with objective measures as we already indicated. Moreover, no research approached absorptive capacity at an individual level of analysis to our knowledge. Therefore, specific metrics were created for three dimensions: acquisition, assimilation and transformation. A knowledge intensity scale (Autio and al.,

2000) is used for exploitation. Before introducing directly the validation of constructs we discuss the operationalization of the four dimensions in this research. Items are available in table 3.

Acquisition

As we adopt an individual approach of ACAP, considering the identification and acquisition of new external knowledge as a process based on knowledge sharing seems to be relevant. Moreover, it emphasizes the importance of individuals' motivation to recognize the value and acquire new external knowledge. We follow several researches (Szulanski, 1996; Zahra and George, 2002; Jansen and al., 2005; Lane and al., 2006; Todorova and Durisin, 2007) to build items that symbolize this first dimension.

Assimilation

Concerning the second dimension of ACAP that is perceived in this study as a real individual activity, we create items that assess individuals' knowledge understanding, interpretation and integration, based on several studies (Powell and al., 1996; Lane and Lubatkin, 1998; Zahra and George, 2002; Jansen and al., 2005).

Transformation

In following an individual perspective of absorptive capacity, transformation should measure the involvement of individuals in combining existing knowledge with the new one and in improving some processes or ways of doing in their company. Szulanski (1996) developed a "retentive capacity" measure which was defined as the "ability of a recipient to institutionalize the utilization of new knowledge" (p. 31). According to us, this variable is partly reflected in the transformation dimension of Zahra and George (2002). Therefore, we refer to this scale to build our items that suggest a knowledge change and integration perspective in order to improve processes through new solutions, new ways of doing, or the use of new tools (Gruenfeld and al., 2000; Jansen and al., 2005).

Exploitation

As we try to develop a global scale for absorptive capacity, it is impossible to use objective measures as mentioned before in the description of this fourth dimension. As a consequence, we look for another solution that give more importance to individuals' actions and

perceptions. Thus, at an individual level of analysis, this exploitation stage should reflect the performance of learning that could be understood in terms of employees' perception of knowledge intensity. This variable highlights the contribution of the knowledge of employees for the realization and commercialization of high-value products and services. We use a scale of Autio, Sapienza and Almeida (2000) to assess the degree of technology, knowledge and know-how delivered in the firms' products and services.

It is important to note that some components of absorptive capacity described in table 1 are not included in this operationalization. Two reasons can be advanced. First, past research mainly displayed an organizational level of analysis using objective measures for ACAP that have no sense at an individual level of analysis. Second, the multiplicity of themes owned by this concept makes its construction quasi impossible at first try. For this reason, this paper, while building on past studies, is still exploratory.

All items of the four dimensions were measured on a seven-point Likert scale, where 1 was defined as "strongly disagree" and 7 as "totally agree". We partially draw on past research to build our scales, mainly on ACAP papers (Szulanski, 1996; Zahra and George, 2002; Jansen and al., 2005; Lane and al., 2006), but also on organizational learning literature. Based on this work, we consider ACAP as a set of distinct but complementary dynamic capabilities following Zahra and George's (2002) arguments. All the measures were presented during research workshops and tested by several professors and PhD students. The objective was at the same time to control the content of each dimension and to check that there is no ambiguity in the formulation of the items. Valuable comments lead us to make some changes to the first version.

It is important to note that this research is somewhat exploratory. Following the objective to examine in depth absorptive capacity, this research goes further than the strict development of scales for each dimension. It also analyzes two other ways of structuring ACAP. First, we test the empirical relevance of splitting ACAP in two subsets - PACAP and RACAP - following Jansen and al. (2005) recommendations. Second, we also analyze the global concept, in considering it as a unified block composed of four distinct dimensions, which remains the more classical way to perceive and use absorptive capacity. In this perspective, this research tries to make a first move in developing difficult-to-measure constructs. A focus is clearly put on the reliability of our scales as Lane and al., (2006, pp. 854) suggest: "While the small

number of empirical studies limits how much we can say about the validity of these studies, our review suggests that scholars should be concerned about threats to construct validity, internal validity and external validity”.

Content reliability was checked at the beginning of the study in two ways. First, the structure and formulation of the questionnaire was tested during research workshops. Second, an expert group, composed of professors and managers implicated in the project, analyzed the relevance of the content of the four ACAP dimensions. This group has validated the content of the four dimensions as indicated in table 2 below. A description of all items is available in table 3. Some items were removed, either because they duplicated the content of another item or because they were ambiguous. This work provided preliminary support to the content validity of our ACAP scale.

Reliability was first analyzed through an exploratory factor analysis, which assess the fit of items in a scale and help to identify factors of correlated items. The 21 items were subjected to a principle component analysis with varimax rotation. Only items with a factor loading greater than 0.40 were considered in the analysis. Cronbach alpha is used as internal consistency reliability indicator. Nunally (1978) recommended to apply a 0,70 level of acceptance. They are available in table 3 and are all superior to 0.76.

We pursue with a confirmatory factor analysis. The combination of exploratory and confirmatory methods is frequently used when building measurement scales (Valette-Florence, 1993; Roussel, 1996). Indeed, the contribution of structural equation modeling after a principal component analysis is twofold: assess the content of a questionnaire and determine the best factorial structure in terms of adjustment to empirical data. Amos 5 used a covariance matrix as input to test the model, which allows to study the underlying causal relationships. Structural equation modeling method allows to check the stability of the scales’ factorial structure, their homogeneity and their discriminant and convergent value.

Table 2: content of ACAP dimensions in this research

Dimensions	Number of items	Theme	Measure
Acquisition	6	Knowledge flow	Prior knowledge and flow of information about internal and environmental changes

Assimilation	6	Knowledge understanding	Discovering of new practices, technologies, actors, products and reconsideration of the current way of working
Transformation	6	Knowledge internalization	Improvement of procedures and practices, use of new tools and speed
Exploitation	3	Knowledge intensity	Contribution of the knowledge of employees for the realization and commercialization of high-value products and services

Convergent validity has been assessed through two complementary criteria: a significant t-statistic for each item level path ($t > 1,96$ and $p < 0,05$) and each path loading must be greater than twice its standard error (Fornell and Larcker, 1981; Anderson and Gerbing, 1988). Each ACAP dimension succeeded the two convergent validity tests, as shown in table 4.

The quality and validity of our scales is checked through five adjustment indicators: χ^2/df , GFI, AGFI, RMSEA and CFI.

Results of the principal component analysis are discussed first and then those of the confirmatory factor analysis. These analyses follow this order:

1. We test each dimension of ACAP separately;
2. We test the PACAP / RACAP distinction;
3. We test the global concept of absorptive capacity.

RESULTS

The following table presents the items of each dimension of absorptive capacity, and also the main results of the principal component analysis.

Internal consistency reliability indicators are indicated, either for the four ACAP dimensions, the classical PACAP and RACAP model and for the global concept.

Table 3: items, means, standard deviation and factor loadings

ACAP	M	SD	Factor loadings*				Cronbach alpha		
			1	2	3	4	a	b	c
<Recipient> is informed about changes in products and services.	4.91	1.64	0.74				0.87	0.77	
<Recipient> is informed about new strategic orientations.	4.44	1.87	0.77						
<Recipient> is informed about technological transformations and innovations.	4.94	1.75	0.74						
<Recipient> is informed about partners' changes.	5.20	1.47	0.72						
<Recipient> is informed about a change of suppliers or distributors.	4.47	1.83	0.84						
<Recipient> is informed about employee's change.	4.26	1.86	0.76						
When meeting external actors : <Recipient> learn new management methods and processes.	3.66	1.77		0.65			0.85	0.83	
<Recipient> discover new suppliers and distributors.	4.13	1.88		0.84					
<Recipient> acquire knowledge about external technical processes and technological innovations.	4.84	1.73		0.85					
<Recipient> reconsider the way of working.	3.84	1.66		0.53	0.47				
<Recipient> discover new products and services.	4.68	1.72		0.80					
<Recipient> have new ideas.	4.57	1.59		0.79					
<Recipient> improve current methods and practices in proposing new solutions.	4.65	1.55			0.79				
<Recipient> improve current methods and practices in finding ways to go faster.	4.62	1.61			0.84	0.84			
<Recipient> improve current methods and practices in changing old processes.	4.91	1.69			0.76				
<Recipient> improve current methods and practices in using new tools.	4.99	1.65			0.77				
We have a strong reputation of technological excellence.	5.36	1.60			0.91				
Knowledge intensity is characteristic of our business.	5.70	1.13			0.77	0.85			
There is a strong knowledge component in our products and services.	5.82	1.27			0.79				

Note: 1 = acquisition; 2 = assimilation; 3 = transformation; 4 = exploitation;
a = 4 dimensions; b = PACAP / RACAP; c = ACAP * Only factor loadings superior to 0.4 are indicated

ACAP dimensions

The four scales that represent the dimensions of absorptive capacity are satisfactory. Indeed, the Cronbach alphas indicate very good internal consistency reliabilities for acquisition ($\alpha = 0.87$), assimilation ($\alpha = 0.85$), transformation ($\alpha = 0.84$) and exploitation ($\alpha = 0.85$). However, it is important to note that two items of the transformation phase do not appear on the same dimension than the four other items when using a varimax rotation. Moreover, the rotated component matrix reveals very different values for these two items in comparison with others. For these reasons, we decide to remove them from the transformation scale, that will be composed of four items in forthcoming analyses. Total explained variance is also important for each factor: 62% for acquisition, 58% for assimilation, 68% for transformation and 78% for exploitation.

Confirmatory analyses indicate that the scales for ACAP dimensions are reliable (acquisition, $R\hat{\rho} = 0.87$; assimilation, $R\hat{\rho} = 0.86$; transformation, $R\hat{\rho} = 0.86$; exploitation, $R\hat{\rho} = 0.86$) with satisfactory results as shown in the following table.

Table 4: results of the confirmatory analyses for the four dimensions of ACAP

	Dimensions of absorptive capacity			
Indicators	Acquisition	Assimilation	Transformation	Exploitation
χ^2/df	1.312	0.906	2.855	2.086
GFI	0.983	0.985	0.993	0.994
AGFI	0.86	0.93	0.93	0.96
RMSEA	0.038	0.000	0.093	0.071
P	0.543	0.785	0.177	0.253
CFI	0.989	1.000	0.995	0.996
Fiability ρ de Jöreskog	0.872	0.860	0.862	0.864
Convergent validity ρ VC	0.53	0.51	0.61	0.68

Pacap / Racap

After analyzing each dimension separately, we test the classical model proposed by Zahra and George (2002) with PACAP (acquisition and assimilation) and RACAP (transformation and exploitation). The objective of this analysis is to deepen our understanding of absorptive capacity, and more precisely of the relations between the four dimensions. Principal

component analysis shows satisfactory results for these two subdimensions. Cronbach alphas indicate quite good internal reliability for PACAP ($\alpha = 0,77$) and RACAP ($\alpha = 0,80$). Total explained variance is acceptable with respectively 60% and 72% for PACAP and RACAP. However, confirmatory analyses reveal some problems. Indeed, while results are acceptable for RACAP ($R\hat{\rho} = 0.50$), they are quite bad for PACAP with a very weak $R\hat{\rho}$ (0.10) and a non-significative RMSEA as shown in the table below. Therefore, results for PACAP and RACAP scales are ambiguous.

The global ACAP model

The third analysis is related to the global concept of absorptive capacity. A principal component analysis is launched on the 19 items used in this research after the suppression of two items of the transformation phase. Items respond on the four dimensions of absorptive capacity. First, results of the principal component analysis show a good reliability of the ACAP scale ($\alpha = 0.83$). Second, the extraction through a varimax rotation provides four factors that are conformed to our expectations and past ACAP conceptualizations (Table 3). Total explained variance is satisfactory with some 66.4%: 19.5% for acquisition, 18.5% for assimilation, 15.2% for transformation and 13.1% for exploitation.

The objective of the confirmatory factor analysis for the global ACAP concept is twofold: investigate the measurement model of absorptive capacity and examine the structural relationships between the four dimensions. First, it is important to note that a second order model could not be validated, because of weak regression weights (<0.5). Second, while ACAP has a satisfactory $R\hat{\rho}$ (0.85), results of the confirmatory analysis are ambiguous. Values for GFI and AGFI are quite satisfactory but results present a non-significative RMSEA and a very weak value for the CFI.

The following table shows the main results of the confirmatory analysis for the PACAP / RACAP constructs and the global absorptive capacity concept.

Table 5: results of the confirmatory analyses for PACAP / RACAP and the global concept of absorptive capacity

Indicators	PACAP	RACAP	ACAP
χ^2/df	2.836	1.174	8.146
GFI	0.879	0.982	0.909
AGFI	0.787	0.902	0.815
RMSEA	0.092	0.028	0.182
P	0.000	0.707	0.000
CFI	0.691	0.997	0.485

Results of these analyses are interesting in several ways. While the scales representing the dimensions of ACAP are satisfactory, the classical distinction of Zahra and George (2002) - PACAP / RACAP – displays some ambiguity, as for the global measure of ACAP. These results deepen our understanding concerning the internal structure of ACAP in clearly differentiating the four dimensions. Moreover, they call for a reconsideration of absorptive capacity as a unified concept.

DISCUSSION AND THEORETICAL IMPLICATIONS

This research puts into question two fundamental issues concerning absorptive capacity research while proposing a scale to measure this concept. Neither the classical categorization of ACAP in PACAP and RACAP (Zahra and George, 2002) or the consideration of ACAP as a unified concept appear relevant in this study. These findings are explored further below.

First, principal component analysis through a varimax rotation indicate the existence of four distinct factors and not the two dimensions of potential and realized absorptive capacity. Moreover, confirmatory factorial analyses strengthen these outcomes in pointing problems of reliability with PACAP and, to a lesser extent, RACAP. Indeed, the PACAP scale displays a bad discriminant validity with a very weak $Rh\hat{o}$ (0.10) and a non-significative RMSEA. Results for RACAP are better but not really satisfactory ($Rh\hat{o} = 0.50$). At last, this two-factor model has the worst results in comparison with the one-factor and the four-factor models. For these reasons, we suggest that the consolidation of absorptive capacity in PACAP and RACAP is not empirically relevant, which is in line with the results of Jansen and al., (2005). Approaching ACAP through potential and realized absorptive capacity may cause some problems of accuracy in the identification of the dimensions that remain clearly distinct and also concerning the mechanisms that can impact each phase.

Second, exploratory factor analysis reveals that the ACAP scale, as a unified concept, is reliable. Four dimensions appear as shown in table 3 and the Cronbach alpha indicate a good internal consistency (0.83). However, results of the confirmatory factor analysis are ambiguous. While ACAP has a satisfactory discriminant validity ($Rho = 0.85$), the model displays some problems of adjustment with a non-significative RMSEA and a weak CFI. These issues ask questions concerning the content and the relations between each dimension and their gathering in one whole scale. In that perspective, our research reveals that a four-factor model provided the better fit to the data. This outcome is not really surprising. First, results are conform to those of Jansen and al., (2005) in pointing out that a four-factor model constitutes a better ACAP scale than the two opposed models considering ACAP as a unified concept or as a two-dimension one with PACAP and RACAP. Second, we believe that the content of the four dimensions of absorptive capacity are really different and that it prevents from measuring it in one global scale. Indeed, our research suggests, either in the literature review through the description of each dimension or in the results of the confirmatory analyses, that the four ACAP phases imply very dissimilar learning activities and processes. Moreover, the competences for acquiring, assimilating, transforming or exploiting knowledge remain intuitively quite different, either at an individual or organizational level of analysis. We believe that these elements could help to explain the rejection of the one-factor model.

In line with our first argument that highlight the need to “destructure” the classical and empirical distinction between PACAP and RACAP, we believe that separating each dimension should provide more accurate results in explaining success levels in organizational learning. Indeed, this perspective should allow to focus on some precise mechanisms and processes according to the phase of development of learning within firms. This issue is not opposed to the one of Zahra and George when they indicate that the four dimensions play different but complementary roles. Recognizing that “the four capabilities are combinative in nature and build upon each other to produce a dynamic organizational capability” (p. 188), this element strengthens our approach that is to treat each dimension separately.

Based on the result that a four-factor model constitutes a better ACAP scale than the one-factor model, we propose to conceptualize ACAP as a time-sequenced chain of learning processes that could take place at different level of analysis (individual, unit, organization or interorganization). This perspective is totally in adequation with the dynamic capability view of absorptive capacity, suggesting that the success of each ACAP phase lies on the efforts

made in the previous step. This argument highlights the fact that it exists a chronology between each dimension, it means that one should recognize value and acquire knowledge before assimilating, transforming and exploiting it. However, while this order is necessary to understand its development, we do not believe that “ACAP follows a multidirectional and fluid path” (Zahra and George, 2002, p. 198). Indeed, we suggest that individuals remain embedded in the different phases of absorptive capacity. While trying to assimilate new knowledge, one can realize that it lacks some pieces of information and thus, getting back to the first stage of knowledge identification and acquisition, before returning to the assimilation step. This consideration comes close the perception of ACAP as a set of dynamic capabilities, but puts into question the fluidity of its development. The intrinsic complexity of ACAP that relies both on internal and external interactions, leading to the use of different knowledge processes and mechanisms, calls for a reconsideration of a linear development. This aspect could be approached through the analysis of each ACAP dimension and content. Piaget (1952) used the terms assimilation and accommodation to describe the transformation phase of Zahra and George (2002). In analyzing these two activities, assimilation and accommodation, he linked them to a change perspective, mainly concerning the knowledge basis of a given firm. This change perspective appears in the acquisition phase as a complimentary process to “recognizing the value”. With transformation, Zahra and George highlight the fact that ACAP is dedicated to bring some change within a firm. Quite differently, Todorova and Durisin (2007, p. 778) argue that “firms transform their knowledge structures when knowledge cannot be assimilated. Transformation represents an alternative process to assimilation”. This idea suggests two comments: first, assimilation and transformation are dependent processes, and second, assimilation and transformation occur depending on the type of external knowledge. While we agree with the first proposition, we definitely have problems with the second one. Indeed, Todorova and Durisin (2007) neglect the fact that transformation is oriented towards action and not only reflection. When assimilation appears as a deep internal process of knowledge understanding, transformation is more concerned with the test of some new thoughts based on acquired knowledge. In that way, transformation can be approached as the first step in a process of knowledge adaptation or creation. Thus, we agree with Todorova and Durisin (2007, p. 779) when they “propose that pieces of knowledge that an organization tries to absorb may move backward and forward between assimilation and transformation processes before they are successfully incorporated into the organizational knowledge structures and ready for exploitation”. We even go further than this affirmation in arguing that it exists some backward and forward knowledge flows

between all the phases of absorptive capacity. Thus, we think that ACAP develops over time through a series of embedded sequences of knowledge acquisition, assimilation, transformation and exploitation that could be characterized by the transition from an individual level of analysis to an organizational one. This perspective, while underlining the complexity of ACAP development, enriches past research in three ways:

- It confirms ACAP as a dynamic capability;
- It suggests that ACAP follows a nonlinear path of development through embedded sequences of knowledge activities. This aspect could lead to the consideration that some individuals initiate the process through the identification of valuable knowledge and that others focus only on assimilation, transformation or exploitation issues for instance;
- It confirms the relevance of the four ACAP dimensions underlined by Zahra and George (2002).

Drawing on past research and current results, we propose a refined definition of absorptive capacity. Both Cohen and Levinthal (1990) and Zahra and George (2002) highlight the fact that absorptive capacity is path-dependent. “By having already developed some absorptive capacity in a particular area, a firm may more readily accumulate what additional knowledge it needs in the subsequent periods in order to exploit any critical external knowledge that may become available” (Cohen and Levinthal, 1990, p. 136). This element has been neglected by academics as Todorova and Durisin (2007) point out. In this perspective, they add feedback loops in their refined model of absorptive capacity, that clearly add a dynamic perspective to ACAP research. “Although Zahra and George (2002) characterize absorptive capacity as a dynamic capability that fosters organizational change and evolution, they do not use thinking in cycles typical of evolutionary approaches to management studies and, thus, fail to capture the dynamics and complexity of the phenomenon” (Todorova et Durisin, 2007, p. 776). However, we believe that they do not extend enough their idea. Indeed, in their model, the feedback loop goes from the end of the process, exploitation, to antecedents -knowledge sources and prior knowledge. This representation does not really describe the evolving process of knowledge change that characterize ACAP. Thus, we propose a new definition of this concept:

Absorptive capacity is a time-sequenced chain of embedded learning processes consisting in four phases that imply backward and forward loops and that could take place at different

levels of analysis: recognizing and acquiring new external knowledge (1), assimilating it in the eyes of existing knowledge (2), transforming it in extending the current knowledge basis frontier (3), and exploiting it to deliver high valuable knowledge and commercial outputs (4).

The originality of this definition relies in three main elements:

- the existence of a complex chronology, a first and a last phase with many backward and forward learning loops to ease knowledge identification and acquisition, assimilation, transformation and exploitation;
- the dynamic perspective of ACAP development through the role of different individuals and groups all along its development that imply continuous exchanges that transcend the frontiers of the firm;
- a change perspective which is, according to us, the essence of this concept.

CONCLUSION

Our exploratory approach of absorptive capacity was to conceptualize it as a series of four distinct learning processes. Based on previous theoretical and empirical papers and future research avenues (Lane and al., 2006), the four dimensions of ACAP were clearly distinguished and considered as interlinked blocks, while using an individual level of analysis. The originality of this research design allows to apprehend ACAP from another perspective and to enrich past studies through three main contributions.

The first one lies in the construction of a measurement scale of absorptive capacity that respect established norms of reliability and validity. It reveals that the classical distinction of ACAP in PACAP and RACAP is not relevant, which is in line with previous theoretical (Todorova and Durisin, 2007) and empirical issues (Jansen and al., 2005). Moreover, we believe that labeling one factor “potential” and the other “realized” implies a performance “trap” that direct more employees’ attention towards “exploitation” activities in opposition to “exploration” ones. It displays clearly a short-term vision which is quite in opposition with the ACAP perspective according to us. At last, results show that ACAP should be approached in terms of four different and complementary capabilities and not as a unified whole concept. Indeed, the four-factor model has the best results in comparison with the two other models. This aspect underlines the importance of individuals in ACAP measurement.

The second contribution consists in the adoption of an individual level of analysis to develop a scale of absorptive capacity based on individual firms' members. It allows to conceptualize it as a time-sequenced chain of embedded learning processes that imply numerous interactions between individuals and groups that come and go between the different phases of absorptive capacity, using specific knowledge processes and mechanisms proper to these dimensions. Thus, our results suggest the existence of backward and forward learning loops and of different levels of analysis that add some complexity to this research domain. These elements underline an evolutionary perspective that is consistent with latest ACAP research (Jansen and al., 2005; Lane and al., 2006; Todorova and Durisin, 2007). Moreover, it offers an accurate view concerning the articulation of the different dimensions and their respective internal role.

The third contribution resides in the assumption that absorptive capacity is a concept directed towards an organizational change perspective, both in theoretical and operational issues. Indeed, we believe that the essence of ACAP is to question existing knowledge processes and mechanisms, to reconsider the current knowledge basis and to develop a new market orientation. These elements appear in the different dimensions we develop in this article. Even if the content of each dimension could be improved or some items criticized, it corresponds to our consideration on absorptive capacity. For instance, we believe that our exploitation scale through the use of a knowledge intensity (Autio and al., 2000) measure reflects better a dynamic capability in comparison with objective measures (R&D intensity, number of patents...) or previous empirical ones (Jansen and al., 2005). Moreover, this scale has very good statistical results and offers the opportunity to use it in forthcoming studies.

Some limitations have to be noticed. First, as few studies try to operationalize ACAP with metrics, we needed to develop difficult-to-measure constructs that could be discussed. In this sense, this study, while confirming some results of Jansen and al., (2005), remains, to some extent, exploratory. Indeed, a set of new scales were developed both for ACAP dimensions that could be improved. For instance, the acquisition dimension does not take enough into account external and relational characteristics of knowledge identification and acquisition. The second limitation lies in the specificity of our sample, composed of high-performing technological SME's. Indeed, some recent articles (Lane and al., 2006; Todorova and Durisin, 2007) point out that ACAP was mainly approached in knowledge-intensive industries, which could interfere with the identification of results that could be applied generally. Moreover, questionnaires were analyzed jointly in this research without taking into consideration some

individual differences between respondents and the distinctive characteristics of participating firms. For instance, small and large organizations display different organizational structures that deal with different problems and resources constraints (Aldrich, 2000), that could obviously impact ACAP development. These elements obfuscate current results. Third, another limitation concerns the instrumentation of the organizational frontier of high-tech SME's which was not taken into account.

Drawing on this last limitation, one avenue for future research could be to offer a better representation of internal and external aspects that have to be included in the operationalization of ACAP. It could enhance some interactions between, from one hand, relational activities of knowledge acquisition and, from the other hand, more internal learning activities, either individual or collective. Making progress in addressing this issue could help research on ACAP to overcome one of its main challenges about whether it constitutes a set of embedded external or internal activities. However, when considering the nature of different knowledge operations, some problems arise in terms of measurement of the acquisition dimension for instance. It deals with many different aspects (prior knowledge, prior investments, motivation, identification of valuable knowledge...) that could not be included in one single-dimension variable. This aspect confirms our results that is to conceive ACAP as a set of four distinct dynamic capabilities that have to be measured separately. Indeed, this approach favors both the richness and the sufficiency of each dimension, and can also help to identify accurately the scope of intervention of social integration mechanisms. It could be interesting also to replicate this study with another sample. It will allow, first, to check the reliability and validity of our ACAP scale and, second, to control for the impact of a specific industry in order to refine or detail past results. While this first attempt to operationalize absorptive capacity at an individual level of analysis is quite satisfactory, its refinement constitutes one of our main future investigations.

In conclusion, by drawing attention on the existence of four distinct and dynamic capabilities, that co-develop through backward and forward learning loops, this paper makes also a contribution to managerial practice in underlining the role of individuals that ease ACAP development and the transition from one step to another.

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Appendix 1: major theoretical and empirical papers on ACAP

Unit of analysis	Study	Sample / Data	Theoretical lens	Modeling	Measurement	Outcome
Country	Mowery and Oxley (1995)	Theoretical	Comparison of inward technology transfer channels and national innovation systems	National ACAP as moderator of inward technology transfer and national innovation systems	Investments in scientific and technical training and economic policies that enforce competition	National innovation and productivity are greater for countries that invest in building their ACAP
	Liu & White (1997)	145 firms from 29 manufacturing industries in China	Innovation in developing economies	ACAP as predictor of innovative output	Investments in R&D personnel	Innovation is driven by synergy between investments in ACAP and investment in sources of new knowledge
Interorganization	Lane & Lubatkin (1998)	69 R&D nonequity alliances between 48 pharmaceutical and 22 biotechnology firms	Organizational learning; resource-based theory	ACAP as predictor of organizational learning in an alliance dyad	8 measures based on valuing (2), assimilating (5), and commercializing new knowledge (1)	ACAP best measured at the dyadic unit of analysis
	Dyer and Singh (1998)	Theoretical	Resource-based theory through a relational view; organizational learning	ACAP as knowledge sharing routines that ease the identification and transfer of valuable knowledge between collaborating partners	Partner ACAP is a function of (1) the existence of overlapping knowledge bases and (2) the development of interaction routines that increase individuals interactions	Importance of overlapping knowledge bases of partners Role of individuals in ACAP development through the creation of interfirm routines that ease knowledge sharing and increase interactions
Organization	Cohen & Levinthal (1990)	1719 business units from 318 firms in 151 lines of business in US manufacturing sector	Organizational learning; economic theory	ACAP is used as predictor of innovative activity	R&D intensity; responsiveness of R&D to learning incentives	R&D creates a capacity to assimilate and exploit new knowledge
	Szulanski (1996)	271 respondents comments on 122 transfers of 38 practices, technologies	Organizational learning, strategic management	ACAP as predictor of effective transfer of best practices within the firm	9 measures that capture the ability to value, assimilate, and apply new technology	Lack of ACAP of the recipient is a major source of "stickiness", defined as difficulties in imitating best practices within the firm
	Cockburn & Henderson (1998)	68186 publications in scientific journal	Industrial / organization economics	ACAP as predictor of research productivity	Not a direct operationalization of ACAP but is reflected by number of scientific publications	Developing ACAP is not adequate; connectedness to scientific community is a key factor in driving a firm's ability to recognize and use upstream research and findings
	Zahra and George (2002)	Theoretical; reconceptualization of ACAP	Organizational learning, dynamic capabilities	ACAP as a predictor of innovation and strategic flexibility	Division of ACAP in PACAP (Potential), "years of experience of R&D department" and RACAP (Realized), "number of new products ideas"...	RACAP allows the creation of a competitive advantage through innovation; PACAP provides strategic flexibility
	Jansen, Van Den Bosch and Voiberda (2005)	769 general managers of organizational units in a multi-financial services firm	Organizational learning	PACAP and RACAP as 2 subsets of ACAP Coordination, system and socialization capabilities as ACAP antecedents	9 items for PACAP (6 for acquisition and 3 for assimilation) and 12 for RACAP (6 for transformation and exploitation)	Organizational antecedents influence a unit's potential and realized ACAP in different ways; managing levels of PACAP and RACAP in a timely fashion
	Lane, Koka and Pathak (2006)	Theoretical; reification of ACAP	Conceptual and empirical review of past research on ACAP	Thematic analysis of 64 main papers on ACAP	For the 64 papers, authors proceed to (1) a summary of the main topics, (2) groupment of papers following an iterative process and (3) verification of the classification	New definition of ACAP Focus on ACAP antecedents and outcomes considering internal and external drivers ACAP as a multidimensional concept
	Todorova and Durisin (2007)	Theoretical; reconceptualization of ACAP	Organizational learning, dynamic capabilities	ACAP as a predictor of innovation, flexibility and performance	A model based on the 3 "original" dimensions of ACAP Integration of a value identification variable before acquisition Reconfiguration of transformation as a central mechanism to ease assimilation	Dynamic model of ACAP with feedback loops Reconsideration of the role of the transformation dimension and the integration of "power relationships"