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Local Search, Cognitive Representations, and Exploration; The Commercialization of Contactless IC Card Technology at *Sony*

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Abstract

Recent studies on adaptive cognition within organizations imply that exploitative learning facilitates exploration (Gavetti & Levinthal, 2000; Gavetti, 2005; Gavetti, Levinthal & Rivkin, 2005; Zollo & Winter, 2002). These findings are in stark contrast to the more traditional dichotomous perspective, wherein an exploitative mode of organizational learning crowds out the explorative one (Levinthal & March, 1993 ; March, 1991). The current paper addresses this theoretical gap. We reconcile these mutually contradictory arguments by decomposing the crowding-out mechanism, and by developing two complementary boundary conditions under which exploitation could be instrumental in fostering exploration. We illustrate the validity of these boundary conditions with the help of a detailed case study on *Sony*. Our findings provide thought-provoking research agendas for the study of organizational learning, as well as an empirical foundation for insights gained through computerized simulations.

I. Introduction

The exploitative mode of organizational learning has generally been said to crowd out the explorative one (Levinthal & March, 1993 ; March, 1991). However, scholars who have studied adaptive cognition within organization imply exploitative learning is in fact instrumental for ensuing exploration (Gavetti & Levinthal, 2000; Gavetti, 2005; Gavetti, Levinthal & Rivkin, 2005; Zollo & Winter, 2002). Their argument is noteworthy because it indicates the possibility that exploitation facilitates ensuing exploration. Unfortunately, these studies are left theoretically un-reconciled with each other. The current paper tries to address the theoretical as well as the empirical gap

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between these two schools of thought. We reconcile the two mutually contradictory arguments (one *for*, and the other *against*) by developing two complementary boundary conditions for the *against* cases: 1) repetitive trials in related contexts, and 2) analogical reasoning based on vicarious learning. A detailed case study on the commercialization of contactless IC card technology at *Sony* illustrates the validity of these boundary conditions.

II. Literature review

1. Cross-sectional and sequential crowding-out effects

The exploitative mode of organizational learning has been said to effectively crowd out the explorative one. As stylized by Holland (1975), and then formalized by March (1991) or Levinthal & March (1993), the relationship between exploitation and exploration is a trade-off. The fundamental assumption for this argument is that exploitation requires distinctively different cognitive and behavioral patterns from exploration (Anderson & Tushman, 2001; Jansen, Van Den Bosch & Volberda, 2006). Exploitation is usually related to improvements and efficiency, while exploration is closely linked to variety, new possibilities, search and radical change (March, 1991). Therefore, although both of them are required for long-term organizational adaptation, organizations tend either to over-exploit at the risk of losing major opportunities for change, or to over-explore, leaving the potential to increase efficiency unfulfilled.

It is further asserted that the proportion of over-exploitative and over-explorative organizations is not evenly distributed. Initiatives associated with exploitation tend to be preferred and selected by resource-constrained organizations, since these initiatives involve less risk, and promise more certain benefits in the short-term. Exploitation is more cognitively favored, and from a behavioral viewpoint, it better fits with existing standard operating procedures. As a result, organizations sometimes suffer from the pathology of a competency trap (Levitt & March, 1988), where exploitation is excessively pursued at the cost of optimal amount of exploration.

Other authors have argued that the effect of this resource constraint or cross-sectional selection skewed toward exploitation is cumulative. In other words, as organizations accumulate exploitative learning, they tend to explore less often (Abernathy, 1978; Argyris & Schon, 1978; Benner & Tushman, 2002; Levinthal & March, 1993; Sorensen & Stuart, 2000). This is due to increasingly tighter coupling among "choices with respect to activities, policies and organizational structures, capabilities, and resources," (Siggelkow, 2001) or structural inertia (Hannan & Freeman, 1984). More specifically, the underlying mechanism behind this sequential effect is that exploitative learning results in increasingly tight coupling among a firm's structure, cognition, resource allocation, rewards, culture, and competencies, as well as

in the demography of the senior team, which favors internally consistent (i.e., exploitative) changes over explorative ones (Adler et al., 2009). Stakeholders also prefer this tighter coupling for its reliability, and select those organizations over less tightly coupled competitors. Therefore, the cross-sectional selection pattern affects the sequential selection pattern in favor of exploitation.

As shown in the arguments above, we can observe two aspects of exploitation crowding-out effect: cross-sectional and sequential. Cross-sectional effects are observed when selections among simultaneously competing initiatives, either inside or across organizational units are considered.[1)] On the other hand, sequential effects are evident when preceding exploitation crowds out the exploration pursued by the identical organizational unit. Although scholars have accumulated empirical verifications for both the cross-sectional aspect (Argyris & Schon, 1978; McGrath, 2001; Stuart & Podolny, 1996) and the sequential aspect (Abernathy, 1978; Benner & Tushman, 2002; Sorensen & Stuart, 2000), some counter-arguments exist for the sequential aspects.

The typical argument comes from scholars who study managerial cognition and adaptive performance. They imply that exploitative learning is in fact instrumental to exploration. More specifically, they argue that the exploitation and exploration facilitate (and constrain) each other in organizational learning (Gavetti & Levinthal, 2000; Gavetti, 2005; Gavetti, Levinthal & Rivkin, 2005; Zollo & Winter, 2002), suggesting the necessity to modify the dichotomous view on exploitation and exploration. According to their findings, cognitive calculation (associated with variation and distant search, i.e., exploration) is formulated on the basis of simplified environmental representations gained by a local search (i.e., exploitation), while a local search is seeded and directed by the results of cognitive calculation. In other words, superior cognitive calculation is not possible without a preceding local search.

These studies are quite noteworthy in that they indicate the possibility for a reevaluation of our established, dichotomous perspective on exploitation and exploration. However, they primarily rely on computerized simulations, and it remains to be seen whether or not their arguments hold in real life examples. Even more significant is the fact that these studies are theoretically unreconciled with those that argue for the sequential, crowding-out effect. The current paper tries to address these empirical as well as theoretical gaps with a detailed case study on contactless IC card technology commercialization at *Sony*.

2. Experiential learning as repetitive trials in related contexts

"Experiential learning" is one of the most typical examples of exploitative learning,

1) Note that March (1991) considered the dominance of those who follow exploitative learning over others who mostly learn in explorative manners.

and its virtue is clearly shown by emphasizing the power of "backward-looking wisdom" (Gavetti & Levinthal, 2000, p.114). Managers' cognitive representations of competitive contexts are very effective tools for adaptation, no matter how crude they may be (*ibid.*). Not only is this because they seed the process of an experiential search on promising regions in the search space, but they also constrain the process from wandering to less attractive regions. In other words, the virtue of cognitive representations is approximately showing where to locally search.

However, the cognitive representations themselves are clearly an outcome of efforts at sense-making (Weick, 1995) with respect to prior experiences; in other words, a higher-order form of experiential learning (Gavetti & Levinthal, 2000; Gavetti, 2005). Such learning enables the organization to simplify its environmental representations (Miller, 1993; Weick, 1979).

It is important to note here that effective representation requires more than simplification, because imprecise simplification could fail to catch important environmental changes. This is described as a "paradox of newness (Gavetti, 2005)." In other words, cognitive representations can be quite self-affirming, as they ignore disproving information (Weick, 1979).

Therefore, in order to simplify environmental representations in a precise manner, an organization is required to understand "action-outcome relationships" in their competitive environments (Gavetti, 2005).[2] Deep knowledge also enables an organization to push knowledge domain's boundaries with higher likelihood of success (Sternberg & O'Hara, 2000). This reasoning should be quite understandable, because without such deep understanding, organizations cannot be sure which elements can be safely disregarded.[3] In other words, precisely simplified environmental representations focus organizations' attention on really critical dimensions for appropriately addressing the requirements of stakeholders.

One possible method for deepening an understanding on "action-outcome relationships" is the use of repetitive trials in related competitive contexts, i.e., a neighborhood search (March & Simon, 1958) or a local search (Cyert & March, 1963; Stuart & Podolny, 1996). Scholars have shown that experiments within an established regime or a tightly controlled search are effective for adapting to new contexts (Ahuja & Lampert, 2001; Leonard-Barton, Bowen, Clark, Holloway, & Wheelwright, 1994; Lynn, Morone & Paulson, 1996).

Therefore, experiential learning based on repetitive trials in related competitive

2) Another approach is reversing simplification (Weick, 1979), in order to preserve requisite variety (Van de Ven, 1986) in organizations. It is argued as one of the distinguishing features of high reliability organizations (Weick, Sutcliffe & Obstfeld, 1999).

3) An analogue of this reasoning in the context of product design management is the difference between an "architect" and a novice firm. Only very well experienced firms could come up with robust design rules, which very selectively specify critical interactions among components (Baldwin & Clark, 2000).

contexts helps organizations to simplify their environmental representations in a precise manner, focusing their attention only on critical dimensions. Thus, the first boundary condition that allows for an exception to the sequential crowding-out effects of exploitation is as follows:

> Boundary condition 1: *When exploitative learning is earned by repetitive trials in related competitive contexts, the ensuing exploration is not necessarily crowded out , but could be facilitated.*

3. Experiential learning as analogical reasoning based on vicarious learning

How could this precise process of simplification (or a selective perceptual focus on critical elements) retain an exploratory nature for organization's adaptation? Given that those who argue for crowding out effects emphasize the peril of outdated cognitive representations institutionalized by excessive exploitation (Nystrom & Starbuck, 1984; Tripsas & Gavetti, 2000), the source of novelty is of critical importance.

One particularly relevant type of experiential learning is analogical reasoning (Gavetti, Levinthal & Rivkin, 2005). Analogical reasoning provides the insights required to adapt to novel contexts. It is an art to find commonalities among seemingly distinct contexts, thus to address the issue of novelty. In managerial settings, managers with analogical reasoning could transfer experiential wisdom from prior competitive settings to a novel competitive setting with unfamiliar problems. By following analogical reasoning, organizations are able to link experiences embedded in one context to seemingly distant contexts. As a result, they could instill novel insights gained at distant contexts into otherwise tightly coupled activity systems, effectively breaking away from learning myopia (Levinthal & March, 1993).

As is indicated in Gavetti et al. (2005), one critical element of successful analogical reasoning is building a rich library of analogy sources. Unless the organization stocks various examples on which analogical reasoning is developed, it will end up repeating what it has done before.

Competing firms comprise one such source of examples. By closely observing both successful and unsuccessful competitors, firms could vicariously learn a variety of strategies and their effectiveness (Abrahamson & Fombrun, 1994; Cyert & March, 1964; Fiol & O'Connor, 2003; Gavetti, Levinthal & Rivkin, 2005). In other words, whether firms have accumulated vicarious learning experiences or not is a critical prerequisite for effective analogical reasoning. Therefore, the second boundary condition for an exception to exploitation's sequential crowding-out effects is as follows:

> Boundary condition 2: *When exploitative learning is earned by analogical*

reasoning based on vicarious learning, the ensuing exploration is not necessarily crowded out, but could be facilitated.

The following section describes a case example that illustrates the validity of the two boundary conditions described above.

III. Case description[4)]

1. Experiential learning; memory media businesses at *Sony*

For *Sony*, the business development of contactless IC card technology was the latest in a history of successive standard wars. The preceding standard wars were related mostly to various memory media businesses.

Trying to build new businesses in the memory media market has been a neighborhood search (March & Simon, 1958) or a local search (Stuart & Podolny, 1996) for *Sony*. *Sony*'s one of founding businesses is magnetic storage media introduced in 1950. The *cassette tape* (1966) and floppy disk (1980) are other examples of major storage media technology standards that were introduced by *Sony*. *Sony* revolutionized our patterns of music consumption by leveraging digital storage technology when it introduced the compact disc in 1982. *Betamax* (1975) and the *memory stick* (1998) were also part of this lineage of business development. As a result, both users' needs for memory media and competitive dynamics were relatively well-known for *Sony*. It had accumulated these learning as it continuously introduced more or less technologically advanced memory media products.

One of the important features with *Sony*'s memory media business development is that *Sony* tried to play a role of platform leadership (Gawer & Cusumano, 2002), evangelizing its new technology standard. In fact, *Sony* was always at the leadership position of its competing coalition. For example, although there were some allied companies for *Sony*, due to very high profile promotional activities and strong technological leadership, people strongly associated *Betamax* or *memory stick* exclusively with *Sony*. On the other hand, *Sony*'s competitors adopted more group-based approach, where the leadership was shared among participants. For example, *SD card* was jointly introduced by *Matsushita* (currently, *Panasonic*), *Toshiba*, and *San Disk*, and then, promoted by an industry consortium, called *SD Card Association*.

Another important feature of *Sony*'s standard war strategy was its hardware-centric approach. In contrast to *Sony*, the *VHS* group led by *Victor* and *Matsushita* emphasized the importance of application software. They focused their efforts on increasing rental video software for *VHS*, which played out quite favorably for the *VHS*'s market

4) The case description is based on Aoshima & Suzuki (2008) and Aoshima, Suzuki & Osanai (2009).

dominance (Cusumano, Mylonadis & Rosenbloom, 1992).

Betamax and the *memory stick* also shared the unfortunate fate of marginal market presence, which effectively questioned the wisdom of *Sony*'s explicit platform leadership as well as its hardware-centric approach. As of January 2008, the *memory stick's* is market share was 13%, while the competing *SD card* held 74% of the total memory media market. *VHS*'s market dominance, and *Betamax*'s consequential withdrawal, is too famous to be repeated here (*Ibid.*).

In the following sections, we will look at how these experiential learning in memory media businesses were useful for the relatively distant business development of contactless IC card technology.

2. Exploration in a new context: *Sony*'s contact-less IC card technology business

Sony's *FeliCa* is one of the few contactless IC card technologies widely adopted for commercial use. Contactless IC card technology is a combination of highly power-efficient IC tip and wireless communication technologies. The IC tip is embedded in a plastic card with the size of a credit card, and memorizes information communicated wirelessly from a reader terminal. Not only is the amount of information storage greater than other devices, but speed and ease of use is also enhanced because the card need not be inserted into a terminal. A quick touch is enough for information exchange between the card and a reader terminal. Typical applications are micro payments, such as buying soft drinks or paying for a train ticket.

In addition to *Sony*, major electronics competitors including *Philips* and *Motorola* were competing in this emerging field. Beginning with its adoption by *Octopus Co.*, a Hong Kong's public transportation conglomerate, *Sony*'s *FeliCa* has been widely adopted not only for electronic ticketing, but also as an electronic money application, mainly in Japan. As of September 2007, 250 million *FeliCa* tips (including over 40 million incorporated in cell phones) have been shipped.

As indicated in the above description of contactless IC card technology, new developments around *FeliCa* technology was remarkably exploratory for *Sony*.

First of all, its technology is closely related to the social infrastructure of transaction or transportation. The business for social infrastructure applications is very different from that of consumer electronics. The primary difference is the order of unit shipments, and consequently, the level of required technological reliability. For example, the accumulated worldwide unit shipments of the *Walkman*, one of *Sony*'s most successful consumer electronics products, were over 236.6 million in 1999, 20 years after its launch, while those for *FeliCa* are already 250 million in its 11th year (primarily in Japan). Needless to say, a wider diffusion means a lower tolerance for failure. Stated differently, the required level of technological reliability is significantly higher for social infrastructure applications.

The second major difference is the corollary of this involvement with social infrastructure. Dealing with semi-public utility type business partners was a relatively new experience for *Sony*. Generally speaking, these partners are more authoritarian and directive than private firms. For example, when *Sony* proposed a cost reduction idea to one of its potential semi-public business partners, they furiously refused, arguing that worrying about the profitability of a public business should not be the job of a private firm.

Finally, at the time of *Sony*'s business development around *FeliCa*, people (including *Sony* itself) only had a very vague idea on what the contact-less IC card technology was for. In the case of memory media, the situation is very different because how it's used and beneficial is quite self-explanatory. In other words, searching for appropriate applications was an inherent part of *FeliCa*'s business development.

Therefore, developing new businesses leveraging the *FeliCa* technology required *Sony* to explore outside of its familiar technological, as well as business fields.

3. Experiential learning applied to exploratory contexts; the commercialization of *FeliCa*

Another salient characteristic of *FeliCa's* business development is the extraordinary efforts at coalition building made by *Sony*.

The inception of *FeliCa* technology goes back to 1988, when *Sony* was asked to develop package routing technology for a major delivery service company. The client wanted to replace manual operation with a remote package sensing and automatic routing system. *Sony* selected wireless communication technology that happened to be unacceptably expensive for the client. As it turned out, this package routing application was not commercialized. However, the idea of remote sensing with wireless technology seemed promising for *Sony*'s engineers, so they continued to work on more refinements.

Shortly after that, *Sony* was contacted by *Japan Railway East's* (*JR East*) research subsidiary for the possible co-development of an electronic ticketing technology. *JR East* was looking for a new ticketing system with reduced operating costs and an electronic ticketing system was one alternative that was considered. *Sony* and *JR East* repeated several experiments in order to see whether *Sony*'s technology satisfied *JR East's* technical and operational requirements.

One of the most challenging tasks for *Sony*'s engineers was the extremely high level of reliability required for the social infrastructure application of railway ticketing. *JR East* required an error rate of less than 1/million cases, which was distinctively higher than the standard of consumer electronics products.[5)] Another difficulty was *JR East* happened to be in the final stage of ticketing system replacement from manual to

mechanical automatic. As the next round of *JR East*'s major investments was in the order of decade's future, *Sony* was forced to find other applications in order to maintain development funding.

The opportunity arose from an unexpected, but familiar source. *Mitsubishi Trading*, who had previously been in talks with *JR East* about importing a wireless tag technology from a United States company called *Amtech* (currently, *TransCore*), had knowledge about *Sony*'s technology and invited *Sony* to bid for *Octopus*'s electronic ticketing system.

Octopus is a public transportation conglomerate operating in Hong Kong. Their service is comprised of various forms of public transportation, including trains, buses, and ferries. Customer ticketing had always been a headache for *Octopus*, especially when customers transferred from one modality to another. With no business opportunity was in concrete form in Japan, *FeliCa* engineers were focused on satisfying *Octopus*'s technological specifications.

The specifications required the card to work without a battery, and the transaction could be processed within 0.3 seconds. The requirements were particularly troublesome, because quick processing consumes a large amount of power, and so requires a with-battery card design. *Octopus*'s needs were that the card was to be designed without a battery, since batteries can be a source of various troubles, including liquid leak. What's more, there were no assurances that a card with a battery could be durable enough for a users' rough handling. Upon *Octopus*'s strong request, *Sony* decided to change its initial technological specifications in order to satisfy *Octopus*'s requirements. Thanks to *Sony*'s very favorable brand image in Hong Kong, *Octopus* selected *Sony* over *Philips* to be the first to adopt *FeliCa* in 1994.

With the successful implementation of an electric ticketing system in Hong Kong, *JR East* now grew more serious about *Sony*'s technology back in Japan. The battery-less design that *Sony* had developed for *Octopus* was particularly critical, and effectively addressed *JR East*'s concerns about *FeliCa*'s long-term reliability.

The battery design was not the only change *Sony* made for *JR East*. *Sony* also changed its wireless communication technology from micro-wavelength to short-wavelength, due to the fear of interference by the human body, as well as cost considerations. All these changes indicate the extent to which *FeliCa*'s engineers were focused not only on hardware, but also on application development. Addressing *JR East*'s needs differentiated Sony from its competitors, including *Motorola*.

Despite all these efforts, it turned out that *Sony* was quite underrepresented for the introduction of *JR East*'s electric ticketing system, dubbed *Suica*. The new service was

5) About 10 years after, *Sony* made company-wide efforts to implement six sigma, which require a less than 3.4 /million error rate. Unfortunately, it was too difficult to implement, even with the support of a consulting firm, *Air Academy Associates*. Then, *Sony* modified the original six sigma, and implemented it as *Sony Six Sigma* in 2000, after almost 2 years of unsuccessful trials.

launched as *JR East*'s innovation, while most people remained unaware that *Sony* provided the underlying technology for *Suica*.

Sony's limited exposure was also evident in the allocation of economic rent between *Sony* and *JR East*. Out of *JR East*'s total initial investment (46 billion yen), *Sony* gained only 2.8 billion yen for 6.5 million cards and 9,100 card readers. One business development manager explained why *Sony* avoided more explicit representation:

> We felt it important to win an application people use everyday. If *FeliCa* is not used everyday, we can't say it is widely diffused. Unlike, for example, civil registration cards, electric ticketing is ideal in that people use it every morning and night. So we were very careful in successfully building a win-win relationship with *JR East*. It's not just us making money, but everyone should make money on *FeliCa* technology.

Another major application of *FeliCa* was, quite coincidentally, launched at the same time as *Suica*, in November of 2001: an electronic money application named *Edy*.[6] The timing was hardly ideal for starting a new electronic money service. Two major earlier entrants, *VisaCach* by *Visa*, and *Mondex* by *Master Card*, had experienced frustrating results since their launch in October 1997 and in February 1999 respectively. As a result, both their business partners and consumers were skeptical about the future of electronic money.

With this background, Mr. *Idei*, then *Sony*'s CEO, made explicit strategic decisions upon starting a new subsidiary for electronic money business. A business manager in charge of *Edy* recalled his conversation with *Idei* as follows.

> He said this service would be a new social infrastructure.....if that's the case, the new company should not be named as *Sony-something*. He also told me we should partner with as many so-called leading companies as possible.....involve them all, then the new service would be a social infrastructure.

The company was then named *Bit Wallet*, in order to gain as much support from potential business partners as possible. While on the surface, *Sony* seemed to be just one of many participants in this new venture, *Bit Wallet*'s beginning capital structure showed that *Sony* held an undeniable leadership position (47%), along with the associated financial as well as reputational risks. It is worth noting that *Sony*, a renowned hardware manufacturer, diversified into an application business in order to secure the successful diffusion of *FeliCa* technology.

On the part of business partners, the delicate balance between limited risks and the

6) *Edy* stands for the initial letters of 3 major currency: the Euro, Dollar, and Yen.

high profile exposure of being involved in an advanced technological initiative made those who had hesitated to join earlier coalitions (including *NTT DoCoMo*, *Toyota*, or *Tokyo-Mitsubishi Bank*) easier to ally with *Sony*. Some banks that had been frustrated with earlier coalitions' failure to penetrate the Japanese market also joined the *Sony*-led alliance.

The application-oriented approach was further evident in the case of *Edy*. For example, *Bit Wallet* formed an alliance with a major airline, *All Nippon Airways* (*ANA*). As a result, members of *ANA*'s mileage club could exchange accumulated *ANA* miles into their *Edy* value. In addition, *Edy* could be used at shops and restaurants at airports where *ANA* is based; it is no wonder then that heavy *ANA* users were some of the earliest adopters of *Edy*.

The business manager who's been responsible for *Edy* business explained why he focused so much energy on the formation of an alliance.

> When I was at *Sony*, I experienced more than enough format wars on *VHS* vs. *Betamax*. During all those format wars, like the *SD card* vs. the *memory stick*, I was there, and I hated them. So, I felt it should never be repeated for *FeliCa*, and tried to invite them all, including competing ones.

Even with the success of *Suica* and *Edy*, *FeliCa*'s potential user benefit was not fully realized by card applications, because users were tied to charge terminals whenever they needed to increase the value stored in a card. In other words, the wide-spread application of *FeliCa* was constrained by the physical locations of charge terminals.

Mobile FeliCa, a *FeliCa* tip embedded in a mobile phone, effectively addressed this issue. In order to commercialize *Mobile FeliCa*, *Sony* established another *FeliCa* related subsidiary, *FeliCa Networks*, with *NTT DoCoMo* in January, 2004. *FeliCa Networks* provides a download service for users of *Mobile FeliCa*; for example, if a user downloads the *Suica* application software for his or her *Mobile FeliCa*, then *JR East* will pay a commission to *FeliCa Networks*. Hence, without the service of *FeliCa Networks*, *Mobile FeliCa* is useless. *FeliCa Networks* complements the technological superiority of *Mobile FeliCa* by providing software which users find useful and enjoyable.

Sony, once again, kept its representation under wraps, with the name of its new company not referring to *Sony* at all. *Sony* also owns the majority of *FeliCa Networks*, so that other mobile carriers that compete against *NTT DoCoMo* could also leverage *FeliCa Networks* for their mobile networks. This sounds reasonable from the perspective of the *FeliCa* business; however, *Sony* is also involved in a mobile phone business, and a too close relationship with *NTT DoCoMo* could jeopardize its

relationship with other clients, including *KDDI* or *Vodafone* (currently, *Softbank Mobile*). The reasons why *Sony* risked this relational damage and went ahead with the establishment of *FeliCa Networks* reveal *Sony*'s strong commitment to building an application infrastructure for *Mobile FeliCa*.

IV. Case analysis

This section discusses the validity of the two boundary conditions developed above. Specifically, we first consider whether 1) repetitive trials in related competitive contexts, and 2) analogical reasoning based on vicarious learning were observed in *Sony*'s experiential learning processes. If they are observed, we will then consider how they contributed to *Sony*'s ensuing explorative adaptations.

1. Experiential learning

Sony had learned from its experiences in various memory media businesses that in order to gain widespread market acceptance, it needed to abandon its hardware-centric approach, as well as its original strategy based on explicit leadership.

Each successive memory media business were closely linked to others both in terms of underlying technologies and competitive landscapes, thus composing a locally searched field for *Sony*. However, at the same time, the competition pattern gradually shifted toward one that was more closely networked. *Sony* was able to introduce and establish the *compact disc* regardless of strong opposition from business partners, including retailers and those in the music industry. This was primarily because consumers mostly focused on the technological superiority of the *compact disc* over analog records. However, in the case of *Betamax* or the *memory stick*, consumers were more concerned about the compatibility between the new technological standards proposed by *Sony* and complementary technologies or services. In other words, the effect of network externality (Shapiro & Varian, 1999) came into the equation, which significantly altered the importance of business partners and software applications.

As shown by comments made by *Idei*, or *Edy*'s business managers, these significant changes in competitive requirements were recognized in a simplified relationship between key strategic initiatives and resultant success, exactly because they were observed across repetitive memory business development experiences in a locally searched field.

Moreover, the contrast between the experiences of more successful competitors and those of *Sony* were quite explicit in the case of *Betamax* and the *memory stick*, where more application-oriented competitors with less explicit leadership gained dominant market positions. This vicarious learning was then applied to the *FeliCa* business by analogical reasoning, which revolved around the common aspects of memory media

businesses and *FeliCa*, i.e., network-based standard wars.

Consequently, these changes were recognized as explicit shifts highlighted against an otherwise stable background. These shifts were then easily coupled with distinct consequences of success and failure. As a result, their importance was undeniably recognized, and learned.

2. Successful distant adaptations

As discussed above, the *FeliCa* business required an explorative search from *Sony*. Not only technological capability, but also business development strategy was drastically changed for the better adaptation to unfamiliar competitive environments.

The first of the required changes concerned the difference between an application for social infrastructure and the one for consumer electronics. The required level of technological reliability for social infrastructure application was almost unheard of at the more consumer electronics-driven *Sony*. In addition, the business partners *Sony* had to work with included semi-public utility type organizations that thought and behaved quite differently from private partners. Finally, application development played a critical role for the wide spread acceptance of new technological standards, i.e., *FeliCa*.

Sony adapted to all of these quite skillfully, thanks to simplified environmental representations gained through experiential learning, as discussed above. A more implicit, or shared, leadership approach allowed *Sony* to learn from its business partners, most notably from *JR East* and *Octopus*. More specifically, a distinctively higher level of technological reliability was realized in the course of trying to meet these business partners' technological requirements. The less explicit, low-key approach also helped *Sony* to assure more business partners, including semi-public ones. This network of allied firms made it easier to realize the benefit of substantial network externality, which is indispensable for the success of a network-based technology like *FeliCa*. Application focus, including establishing new subsidiaries, led to a successful search of appropriate uses for contactless IC card technology. As a result, *FeliCa* is now used for a wide variety of applications from micro payment and coupon distribution to entrance control.

As is explicitly shown in the case description, the two boundary conditions are complementary. Even if *Sony* conducted repeated trials in related competitive contexts, it would have not been able to gain any novel insights without analogical reasoning based on vicarious learning. Likewise, analogical reasoning based on vicarious learning would have been of no use for *Sony* if the company had not experienced repetitive trials in related competitive contexts. This is because it would have been very difficult to judge which new insights would be useful for its new competitive contexts if no precisely simplified environmental representations existed.

V. Discussion

The goal of this paper is to substantiate the argument on the anomaly in the dichotomy between exploitation and exploration. First of all, we showed those arguments on adaptive cognition within organizations are applicable to a real life example by a detailed case analysis. These authors emphasize the complementary relationship between cognitive calculation and a local search, indicating exploitative learning's positive effects on ensuing exploration. Our case description shows that the experiential learning gained through a local search in memory media businesses played a critical role when *Sony* tried an exploratory search regarding how it should adapt to the new competitive environment of the contactless IC card business.

Second, we reconciled two competing arguments (one *for*, and the other *against*) on sequential crowding-out effects. Exploitation might crowd out exploration in a cross-sectional resource allocation. However, in a sequential context, exploitation could, in fact, make the ensuing exploration easier and more certain. We developed two boundary conditions for these exceptional cases: 1) repetitive trials in related contexts, and 2) analogical reasoning based on vicarious learning. It is because preceding experiential learning provides for simplified representations to be applied to novel competitive environments in a precise manner.

Our argument offers several theoretical contributions to the field. First of all, this paper is, to our best knowledge, the first trial to provide an empirical foundation for the arguments implied in Gavetti & Levinthal (2000), Gavetti, Levinthal & Rivkin (2005) or Gavetti (2005). Although their argument is noteworthy in that it represents a meaningful anomaly in the well-established literature on exploitation's crowding-out effects, their computerized simulation approach suffers from inherent limitations. Case studies are appropriate for explaining causality (i.e., internal validity), while statistical analysis is appropriate for establishing generality (i.e., external validity) (Yin, 1994). The computer simulation is a unique research approach because it combines the best of two more widely used research approaches; causality of case studies and generality of statistical analysis. However, the findings from computerized simulations should still be tested by case studies, because there is no assurance that proposed relationships will hold in the real world, with the interference of countless interactive factors. The current paper addressed this issue with a detailed case study.

The distinction between two aspects of crowding-out effects, i.e., cross-sectional and sequential, is another of our contributions. Scholars have discussed exploitation's crowding-out effect, but whether the effect is cross-sectional or sequential has seldom been made explicit. This neglect should not be problematic, if exploitation always crowds out exploration. However, the distinction is found to be significant, because we

are able to observe contrasting relationships between exploitation and exploration by looking at these two aspects separately,

The current paper also provided a thought-provoking research agenda for the study of organizational learning. The two boundary conditions developed in this paper present a group of intriguing research questions. Does exploitation stifle or promote exploration? Under what type of circumstances is exploitation beneficial for explorative adaptation? Are there any specific organizational capabilities or managerial approaches that facilitate a positive relationship between exploitation and exploration? Now that the general validity of the sequential crowding-out effect is under a serious doubt, this research agenda looks increasingly promising. This line of inquiry will surely be more fruitful than continuing to employ a dichotomous perspective that just asks for either exploitation or exploration. As cross-sectional crowding-out effects have been addressed by those who argue for ambidexterity both in structural (Tushman & Romanelli, 1985) and in contextual (Gibson & Birkinshaw, 2004) approaches, the sequential crowding-out effect should also be re-evaluated from renewed perspectives.

We define exploitation and exploration as mutually exclusive and collectively exhaustive categories of organizational learning. It is also accepted that exploration seeds ensuing exploitation. Thus, if we do not allow exceptions to sequential crowding-out effects, exploration should come from something other than organizational learning, which is quite difficult to accept. We believe that there is much to discover in future work on the interplay between exploitation and exploration.

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