Department of Business and Management

Chair: International Business

Organizational Routines, a broader analysis through the Mirror Neuron System

Supervisor

Prof. Alessandro Marino

Co-Supervisor

Prof. Maria Isabella Leone

Candidate

Federica Teresa Catanzaro

681171

Academic Year 2017-2018

Ai miei nonni, la parte più bella di me

Table of Contents

Introduction

The concept of organizational routines was at first developed by Nelson and Winter in 1982. They can be described as "*repetitive, recognizable patterns of interdependent actions, carried out by multiple actors"* and may represent a great source of advantage for organizations. From that moment, the concept of routines enlarged greatly as being taken as basis in different contests and theories. However, their nature is still subject of discussion among scholars. Indeed, they have been at the centre of several organizational models. According to evolutionary economics[i], they assume the role of genes forming the DNA of an organization. While, for the Resource-Based View, they can be described as micro-foundations (actions/behaviours at individual level) aiding to the formation the so-called macro-foundations (collectivistic modes of action) and can be an important element for the formation of strategic capabilities.

Another issue is linked to the sources forming them. For sure, the context in which they develop is of outstanding importance (i.e. culture, individuals' behaviours etc.). That is the reason way they cannot be copied blindly from external sources: they need to adapt in accord to the environment to be effective. Therefore, routines can be described as the "memory of an organization" and accounts both implicit and explicit knowledge used within its margins. There may be identified two different types of routines, called respectively Operative and Strategic Routines. The former represents all static rules that direct the behaviour of all individuals between the organization in the short run. While the latter is formed by series of dynamic rules that drive the growth of the company and favour innovation.

In the last few years, the concept of organizational routines has been accounted in different contests, such as law, medicine, accounting or engineering. Although the role of routines within the borders of the company is without any doubt important, it is not easy to clarify their exact origin: how they are created and through which mechanisms they spread. To answer to these questions, in 1994, Cohen and Bacdayan developed an experiment called *Target The Two* (TTT), to prove that the creation of organizational routines can be influenced by the so-called *Mirror Neurons* and that routines are store in the *Procedural Memory*. Cohen's starting point was that during the '80s the neurophysiologist Rizzolatti argued the existence of a neural network, called *Mirror Neuron System*[ii], which has an important role in the coordination with other individuals via imitation of actions. However, the real strength of Mirror Neurons is not just that they enact imitation, but that they seem to allow subjects to learn from imitating the others. Consequently, they may have an important role in the

process of routinization. Regarding procedural memory, it consists in a type of long-term implicit memory that helps in the memorization of motor and cognitive skills and it is usually differentiated by the declarative memory. They can be thought as two machineries working for different aims: procedural memory to store the "knowing how", while declarative memory as the "knowing what" mechanism of storage.

In this thesis, the aim is to investigate the definition of organizational routines and their acquisition through the mechanism of Mirror Neuron System. To do so, we are going to study: (i) at first the characteristics of routines, as well as their history and the elements that can in some way influence them; (ii) successively, the analysis will concentrate on discovering in detail what Mirror Neurons are; (iii) to verify whether MNS has role in the constitution of routines and if they are stored within the procedural memory, we have been developing a personalized version of Cohen and Bacdayan's Target The Two Game; (iv) finally, we are going to see other successive development of the TTT game proposed by Egidi and Bonini to confirm the presence or absence of two important features of two important characteristics of routines: flexibility[iii] and coordination.

1. Organizational Routines

1.1 Broad General Framework Regarding the Routines

According to almost all scholars, organizational routine can be easily described as a series of coordinated, repeated and consequent actions that become of outstanding importance for the rightful functioning of an organization. Without routines, organizations would suffer a strong loss in efficiency as structures of collective action.

Although the "concept" *per se* can be initially attributed to the Carnegie School in 1922, the first *real* "draft" of the concept was given by Nelson and Winter in 1982 and, since then, the concept developed greatly. The first idea proposed by the two authors was exposed in "An Evolutionary Theory of Economic Change" where they identify routines as similar to genetic factors in the social realm.

The analysis of routines may start by taking in consideration some fundamental elements on which companies rely. These are mainly three:

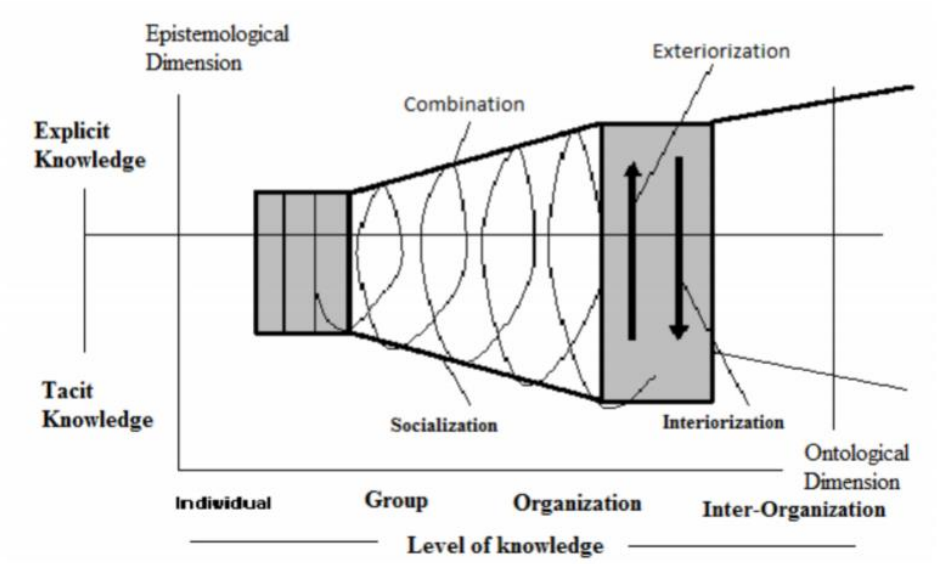
- Organizational data that can be collected through internal and external databases;
- Organizational information, groups of different data and documents having the same subject and scope;
- Organizational knowledge. This term refers to planned groups of ideas and perspectives, values and attitudes and various know-how kept for a long time by the company and that are used operationally for the business;

According to Nelson and Winter, organizational knowledge is saved within routines. Routines can be considered as "the memory of the company", since they represent, implicitly or explicitly, all those series of actions on which the company is built upon. There may be identified two different types of routines, called respectively Operative Routines and Strategic Routines. The former represents all static rules that direct the behaviour of all individuals between the organization in the short run. The latter is formed by series of dynamic rules that drive the growth of the company and favour innovation. The real power of these systems consists in their ability to reorganize all the assets in the best strategic "fit" for that specific company.

There are some necessary conditions that need to be satisfied to create routines:

- Intentionality. It consists in the will of the individuals in the company to reach some predetermined goals. In this case, the presence of a sponsor or a middle manager that promotes one action or idea is essential;
- Individual autonomy. Workers must have the possibility to act freely in order to create new opportunities that can surpass some old standard;
- Fluctuations/ external noise/ creative chaos. Companies need to be influenced by the external environment. It is possible that firms may adopt some behaviour or procedure from other actors with similar characteristics or resources such as suppliers or possible competitors. However, coping blindly from outside is not enough. Companies also need to recognize how to get information from outside and being able to adapt them to their operating field;
- Repetition of information. Replicating information is a good mechanism that can help individuals share more and more data in a quicker and more efficient way. Apart for that, it can provide organizations with an instrument of control;
- Minimum required variety. It is the capacity of answering in a good way to external and internal pressures;

Since organizational knowledge comes also from the contribute of individual knowledge of the members of the organization and the way they spread across the borders of the company, Nonaka and Tekeuchi (1995) analysed how routines can be created and spread through a spiral process in which tacit and explicit, along with individual and organizational, attitudes interact in numerous ways creating different outputs. Tacit knowledge is understood as what people know implicitly. Generally, it involves personal experiences, ideas, values or emotions. On the other hand, explicit knowledge is defined as systematic and sharable information such as data or scientific formulas. By taking in consideration two different dimensions – the epistological and the ontological one- the two authors argue that for the creation of knowledge what is needed are the right conditions providing the creation and accumulation of knowledge at individual level. Later on, all the personal know-how can be elaborated and absorbed by the company.



The system that triggers all this spiral process is communication. Communication represents the "glue" and the "channel" through which it is possible to create value and then spread it. It is not just an important instrument to coordinate all activities, but it is also a way to enhance relations among individuals and consequently the sharing of new ideas, values and strategies. Communication can be of two different plans:

- Strategic. It is a type of meta-communication, aiming to create consonance (strategic compatibility within the structure of the company) and resonance (trust, commitment) with the "receivers" of the message. It is a type of long-run framework on which successive short-run communications can take place;
- Operative. These are the "short-term" communications that aim to reach a specific scope in a specific period of time.

So, as it is possible to understand, routines are quite complicated, and their analysis can be very long. However, it is obvious how they may represent a form of strategic advantage for a firm. Since routines can be understood as social replicators, mechanisms that can pass (or replicate) certain behaviours and knowledge, their importance has been overwhelmingly praised in the area of Resource-based view of firms.

1.2 Resource-based view, the role of micro-foundations and routines

According to the resource-based view analysis, micro-foundations are an important factor in strategic management. Scholars argue that micro-foundations, the level of individual actions and their strategic interaction, are important for many reasons such as resource value constitution or strategic implementation. The reasoning for this analysis lies in the argument that macro (or "collectivist") mode of description is not able to explain all the phenomenon of constitution and spread of resources and capabilities. Thus, the micro-level replaced the macro-level analysis in the description of how routines/capabilities are formed, and how performance is influenced by them.

Coleman (1990) believes that micro-foundations are important in strategic management for three main reasons; alternative explanations, managerial intervention, fundamental causes and predictability.

- Alternative explanations. The problem with macro-level explanation is that it gives just a broad definition of a problem while there might be many lower-level explanations that cannot be studied in detail. That is why micro-foundations can be more representative and more specific for the research;
- Managerial intervention. A fundamental argument that is important in the understanding of micro-foundation is in the fundamental definition of strategic management: to enable managers to gain and maintain competitive advantage. In order to achieve this goal, managerial intervention is required, which inevitably is undertaken at the micro-level. For example, managers can influence capabilities, by hiring key employees or by changing overall recruitment policies, systems, etc;
- It is not possible to conceive capabilities without an understanding of the individual actions and interactions that produce a capability.

Coleman convinces that all the studies involving the use of micro-foundations variables are more stable, fundamental, and general than macro level explanations:

An explanation based on an internal analysis of system organization behaviour in terms of action and orientations of lower-level units is likely to be more stable and general than explanation that remains at system level. Since the system's behaviour is in fact resultant of the actions of its component parts, knowledge of how the actions of these parts combine to produce systematic behaviour can be expected to give greater predictability than will statistical relations of surface characteristics of the system. (Coleman, (1990).)

So, since strategic management is concerned primarily with being prescriptive, Coleman's main idea raises an important concern: the ability to predict is a condition for putting forward prescription. Micro-foundations are therefore an important part of strategic prescription for a company.

According to Abell and Felin, routines can be seen as a micro-foundation for the future development of organizational and dynamic capabilities. More specifically, they are seen as important tools to understand crucial knowledge-based phenomena as heterogeneity, competitive advantage, diversification patterns and innovation. Routines may be also associated with a high-productivity equilibrium since they lead to a better coordination and use of the resources. However, it has been demonstrated that the pattern followed by the resources to build the competitive advantage is never straight and consequential, but it can entail individual skills, motivations and actions. Consequently, it is not easy to understand how some results are practically reached. Still according to Abell and Felin, the relation between routines and capabilities can be explained with the following statement:

A firm can be described as possessing the capability to realise a routine to the degree that it can be repeatedly internalise a pattern of individual level external productivity effects. (Abell, Felin, & Foss, 2008)

This definition implies that there is more to a routine than merely sequentially organizing the productive effort of a number of independent agents. Their efforts are interdependent, and these interdependences can be repeated. A possible question that may arise from this definition is why routines should not be credited to the co-operative actions of different individuals rather than to the organizations themselves. The reason lies in the fact that routines, after they have been created and adopted by the firm, are institutionalized and therefore they are not touched by possible turnovers of employees or managers in realising their capability.

1.3 Main Features of Routines

So, as previously said, Nelson and Wilson firstly described organizational routines as a series of coordinated, inter-locking and reciprocally-triggered actions that become of outstanding importance for the rightful functioning of an organization. Consequently, it might be possible to misunderstand the term "routine" with the so–called "*standard operating procedures*". The main difference is that while routines are designated patterns of

organizational actions, standard operating procedures are rules more explicitly formulated and have normative standing. Thus, the working routines of an organization may or may not be equivalent to its official standard operating procedures. This gap becomes clearer by thinking that standardized procedures might not be able to manage or help handle real – time situations and the use or less "technical" procedures becomes necessary.

Another element that must be accounted is the difference between "*habit*" and routine. Although habits are conceptually different from routines, they share some key elements. Andrews defines habits as "*a fixed way of thinking, willing, or feeling acquire through previous repetition of a mental experience*". So, while the term "routine" is referred exclusively for describing organizational actions, the term "skill" or "habit" is often used at the individual level. Habits, since they are personal, are generally carried out unnoticed and are not automatized by the company.

Habits have been described as a system which entails a simple association between situation and action. Thus, habits can be described by a certain situation (S) and a single action (a) to take within that situation ($S \xrightarrow{a}$). Moreover, the habits' system does not include possible unforeseen events and cannot consider current perceived needs by the agents. Not so long time ago, Cohen hypnotized that a general routine can be constituted just by a series of individual habits that respond to specific needs and behaviours of the individuals belonging to the organization.

In their outstanding work *An Evolutionary Theory of Economic Change* (1982), Nelson and Winter link the concept of routines with the concept of gene. Their basic idea is very simple: they not only are micro-foundations for the structure of the company, but they can also help it develop since they can evolve. This similarity to biological genes is strengthened by thinking that routines can also adapt to environmental changes and can also provide elements of evolutional revolution. From a more practical point of view, Pentland argued that the performance of routines requires daily selection of series of actions from a list of possibilities. On the basis of such basic understanding, routines are then chosen according to criteria of efficiency that must get along with other routines or assets of the company.

In the past, the study of the routines has been largely proved also through field observation.

Indeed, by setting specific subject groups, the presence of recurrent and repeated behaviours has been largely proved. Consequently, it is possible to name these repeated conducts as "main features" of organizational routines.

So, these characteristics are basically four:

- Reliability. Routinization, with time, is able to increase the ability of the members of the organization to produce acceptable results and consequently increase the trustworthiness of certain procedures;
- Speed. Along with reliability, routinized actions are implemented faster than procedures that are generated freely by the members of the organization;
- Repeated Action Sequences. A main element of routines is that the actions that form them are basically the same over time;
- Occasion Suboptimality. One of the main disadvantages of routines is the observed tendency to "fire on" automatically in circumstances where their application is actually not needed, but where instead the execution of other actions would have been more appropriate.

1.3.1 Elements to consider in their analysis

In general, it is possible to identify different series of variables that help simplify our analysis of routines. The numerosity of these elements depends on the very huge amount of studies have been implemented after Nelson and Winter's first definition.

Starting from the base, one key element that needs to be considered in order to understand routines is Repetitiveness/ Persistence. Indeed, without repetition, the creation of routines is unconceivable and, consequently, it is repetition without much change that renders routines stable and durable.

Routines are also a collective phenomenon. Recognising their collective nature has important implications for understanding the concept of routines. It entails that routines have one specific property: they can be distributed. Distributedness means that knowledge held by different members of an organization does not completely overlap and can also obscure the complete knowledge of the organizations. The distributable nature of routines gives rise to intransparency and complexity.

Successively, we can see how routines are, like habits, self-actuating. This is due to the fact that their implementation does not require any reflection or volition and consequently, they are very automatic. So, routines do not require any attention and individuals within the organizations are not aware of them as long as they run smoothly.

Another element that needed to be pointed out is their processual nature. As Pentland and Rueter pointed out, the processual nature is "*the crucial nexus between structure and action",* illustrating how this concept offers a great opportunity for making routines accessible. Many psychological studies verify how the continuous repetition of the same processes leads to the acquisition of those processes by the company.

Many authors showed how routines are embedded in an organization and its structures and, consequently, their particularities are specific to the context. These scholars also identify some reasons that can explain why routines are characterized by specificity and are context-dependent. Firstly, as said before, routines are a consequence of the repetition of some processes. These processes are generally designed on the main features of the company (resources, culture, etc.). Thus, successful application depends on the specificities of the context in which routines are applied. Secondly, the context is quite important since routines can "exploit" some possible synergies or complementarities that can exist among the divisions of the company. Thus, the superficial application of the same rules to two different environments will always be incomplete. This transfer will require "repair skills", such as interpretation and judgement skills, for example to know what routines to perform. So, a whole ensemble of "personal skills" of the adopting company is necessary to put routines in play. Moreover, there are several kinds of specificity that can be identified in literature:

- Historical specificity. It derives from some elements that anchor some processes because of the "history" of the company intended as its culture, values and attitudes.
- Local specificity. This is due to the fact that routines and processes are inserted into a certain constellation of environmental factors;
- Relation specificity. So, it regards in the links that can embed the organization in the actualization of some attitudes/routines;

The most important implication of specificity is that routines are transferable to other contexts only to a limited extent. When they are removed from their original context, they might not work or be as effective as into another context. Problems with the transfer of routines can also be consequent to the fact that routines are always completely understood. Because some managers just "copy" blindly some procedures from another context, without really understand them, they might be incompatible with the new context.

It is well recognised that routines are path-dependent and formed by the personal history of the company. In fact, routines are built from the past: they are able to develop from their past experiences.

Knowing that routines depend on the history is very important since it helps to reconstruct their path and the problems they may arise. *"The experimental lessons of history are captured by routines in a way that makes the lessons, but not the history, accessible to organizations and organisational members who not themselves experienced the history*". (Levitt & March, 1988)

Routines are not essential just for the formation and the development of the company, but they also cover two important roles: they coordinate and control the operations of the company. Their coordinative power comes from their ability to link simultaneously different activities together and to allow various types of interactions. As coordinating instruments, routines are more efficient than contracts since they can be substituted and quicker to establish. Many studies have analysed how routines, since they are standardized, are easier to control and consist in a reliable instrument of monitoring of non-routinized behaviours.

According to Nelson and Winter, organizational performances have two different aspects: cognitive and "motivational" or "governative" aspects. By focusing on this second aspect, the two authors identify a kind of "truce" between workers and management that ensures that the usual amount of work gets done with a usual frequency. So, the notion of truce is of basilar importance since it allows to explain why routines are established and why they are maintained.

Routines also economize on the resources; more specifically, on cognitive resources. The term "cognitive resources" is referred to the experiences, intelligences, competences and task-relevant knowledges of the individuals of the organization. Economising resources is an important role that is fulfilled by routines since this can lead to lower governance costs and to an increase in efficiency.

Consequently, freeing up mental sources of the actors is a strong contribution to their ability to cope with complexity and uncertainty. So, it becomes possible to act even when there are problems in evaluating different alternatives and doubts about the reliability of other partners. Thus, routines lead to phenomena of reduction uncertainty. Many empirical studies have demonstrated how routines can limit uncertainty even in the strongest forms. In

particular, the most important result is that not only routines actually reduce uncertainty but also, they help reduce the uncertainty *perceived* by the workers.

Empirical studies have also enlighted that routines show the phenomenon of inertia. Routines seem to crystallise easily and quickly especially in some specific sectors or environments (such as industries that rely very much on bureaucracy). Obviously, inertia entails that routines limit further changes. Indeed, as many scholars explain, they can also be one important factor for the evolution of the organizational system due to an internal dynamic-participants responding to the outcomes of previous interactions with a routine. In conclusion, it is undeniable that routines can contribute to both stability and change and are indeed an important part of organizational flexibility.

Finally, routines embody knowledge. Nelson and Winter propose that the routinisation of activity in an organization constitutes the most important form of storage of the organisation's specific operational knowledge. In fact, they represent depositaries of collected knowledge in the firm in the sense that they represent successful solutions to many problems.

Elements to consider	Main features
Repetitiveness	It is the core characteristic of routines
Collective phenomenon	Routines are specific of certain culture and societies
Distributedness	The knowledge held by the organization does not overlap and can also obscure the complete knowledge of the organizations
Self-actuating	They are very automatic. So, routines do not require any attention for their implementation
Processual nature	Routines are a consequence of a process of transformation and adaptation
Specificity/ Context-dependent	Routines are tailored of some companies and context
Path-dependency	Routines are built on the past: based on their previous state, routines adapt to experience incrementally in response to feedback about outcomes.
Coordination/control	Routines are more efficient than contracts since they can be substituted and quicker to establish
Truce	It ensures that the usual amount of work gets done with a usual frequency
Economization of the Resources	Economizing resources is an important role that is fulfilled by routines since this can lead to lower governance costs and to an increase of efficiency
Reducing Uncertainty	They have the ability of actors to cope with complexity and uncertainty
Embody Knowledge	Nelson and Winter also propose that the routinization of activity in an organization constitutes the most important form of storage of the organization's specific operational knowledge

1.4 Difficulties in understanding the real nature of routines

From the previous paragraph we can see how routines, in both good and ill, structure organizational behaviour very deeply. As such, they are a major resource of competence. When the decision-making process becomes a heavy burden for the company, they can become a useful instrument for reducing recurring costs. When experienced processes are transferred to specific situations, they not only provide a major determinant of the short-run responses to external stimuli, but they do so efficiently by decreasing the effort spent on decision-making and implementation. Without routines, organizations would not be as efficient as they actually are.

As previously said, organizational routines are specific. Consequently, their implementation in other companies can be bad. However, this same effect can happen also within the borders of the same company. For example, control room operators' vigilance may erode when they become so accustomed to answering each safety check "okay" that they do not see trouble when it is present.

Since "organizational routines" are patterned consequences of learned behaviour involving multiple actors that communicate and interact, they involve not only an institutional part, but also heterogeneous objectives given by the personal capabilities or values/attitudes of the employees of the organization. As previously said, the term "routine" must be distinguished by the term "standard operating procedures" indicating more explicitly formulated rules that have normative standing. Thus, it is important to notify that the understanding of routines is hampered by three different characteristics:

- Routines are multi-actor and thus, their observation can be very hard;
- Organizational routines provide productive conditions for the evolution of behaviour patterns by experimental learning rather than explicit decision making. Moreover, their emerging is "contaminated" with extraneous, historical elements that were previously contained by the cultural luggage of the company. Routines may also preserve objects of old technologies that are considered to be obsolete;
- The underlying knowledge of the parts of routines held by individual actors is often inarticulate. Although managers and the most experienced individuals seem to understand "routines", this is not true. Indeed, they cannot put in words their nature and their implantation;

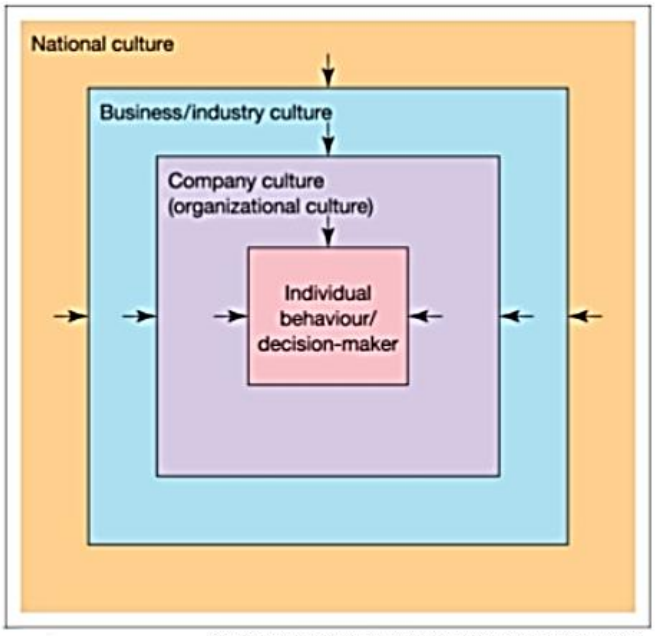
Until now, although we have been taking in consideration many elements characterising the concept of routine, we did not point out a specific or institutionalized definition. That is due to the fact that, the concept of routines has been used with different meanings from different researchers and using different criteria.

Starting from that, the studies that can be approached are very diverse. A first one takes in consideration possible external "stimuli" that can influence the behaviours within the company. Surely, one important stimulus is culture.

Culture can be defined as the learned ways in which a society understands, decides, and communicates. Although the concept of culture is broad and complex, it encompasses several elements:

- It is learned: it is acquired by people over time through their membership to a group that conveys culture from a generation to the other. By taking in consideration national culture, individuals start to learn it at a very young age. Indeed, by the age of five, children can already communicate using both verbal and non-verbal language. Moreover, they internalize elements like:
  - The interaction with members outside the familiar context;
  - Eliciting rewards and avoiding reprimands;
  - Negotiating;
  - Creating and avoiding fights;
- It is interrelated: so, one element of culture is deeply connected to the others;
- It is shared: that is, tenets of culture extended to other members of the group. The cultural values are transmitted to others by other members of the social group. These include parents, social institutions and so on;

The different layers of culture



Source: Svend HOLLENSEN, Global Marketing, 7ed, Pearson 2016

The behaviours adopted by individuals can be influenced by different layers of culture. As it is possible to see from the graph, these are:

- National Culture. It is the element that gives an overall framework and comprises of both cultural concepts and legislation;
- Business/Industry culture. Every business has its own rules and ideas characterized by certain competitive framework and within specific industries. However, we need to take in consideration that sometimes these different cultures/frameworks can overlap even if in general, the borders should always be remembered and considered.
- Company culture (Organizational culture). The total organization often constrains subcultures of various genres. Company culture is expressed by series of shared values, beliefs, meanings and behaviours that create sentiments of unity among the members of an organization;
- Individual behaviour/ decision-making. The individual is, indeed, affected by other personal influences. In an interactive environment like the one of an organization, it is important to recognise how an individual's culture is actually subjected to several different elements that can successively become important within the borders of an organization;

1.5 Procedural Memory

Cohen, starting from the concepts of micro-foundations and habits, recognizes that organizational routines seem to rely substantially on the so-called *Procedural memory or Implicit memory*. Procedural memory is a type of memory that is in charge of storing individual skilled actions for both motor and cognitive skills. It is distinguished by the so-called declarative memory or explicit memory which is the other type of long-term storage memory that regards facts, propositions or events. The main difference between the two that can help to explain how they work is found in the analysis of patients affected by amnesia.

This type of individuals, although they do not remember daily exposures to therapies or interventions, are able to undertake more difficult tasks (such as playing chess and so on). That shows how, through explicit memory, they are able to perform certain objectives, but they are also unable to understand how they reached those goals. Though both types of memory have much in common, studies have shown how they have distinctive characteristics. More specifically, scholars focus on three. First of all, procedural memory is less subjected to decay, more difficult to access, and less easy to transfer to novel circumstances. Proofs of durability of procedural knowledge can be found in the long-lasting durability of the skills that are stored (a good example is given by riding a bicycle). People may forget grammar rules, but they can recognise when a period is well written or not. Such distinction proves how explicit memory durability is shorter than implicit memory storage.

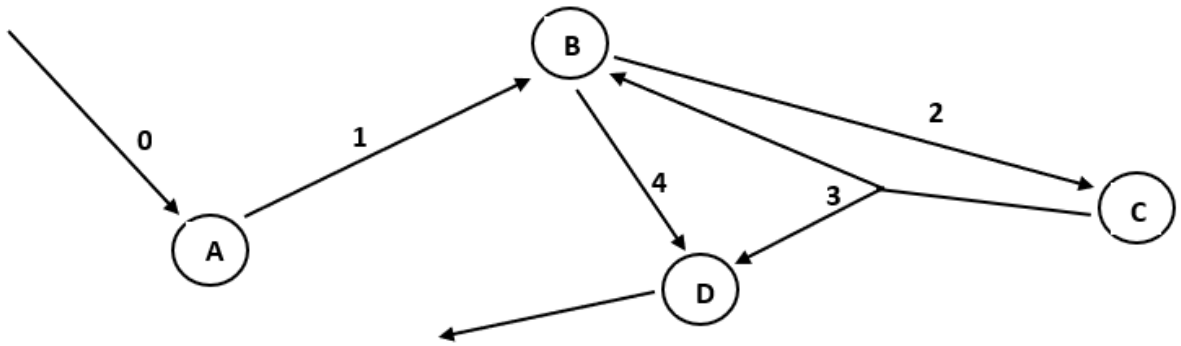
The second important difference lies in the level accessibility of the two. The lowered accessibility of procedural memory has been detected in diverse studies that saw how a response is acquired not when it is written but when it is visualized. On the other hand, declarative knowledge can be acquired both through written and visual methods.

The last element to consider consists in the range of transfer of procedurally knowledge. In particular, Singley and Anderson (1989) demonstrated how, although two knowledges can be strictly correlated, one skill cannot be transferred into the other. This is very obvious taking in consideration mathematics. For example, the two authors found by studying Brazilian school children that although they could currently determine on the street the total cost of a purchase such as five lemons at 35 cruzeiros a piece, they could not compute $5 \times 35 =?$

The idea behind the development of a psychological approach to the study of the creating of routines is linked to the possible "exploitation" of their parallel transfer effect. Groups of people get better at doing "the same" thing. This process leads to the creation of learning curves. However, the opposite effect also persists: this phenomenon of transfer can lead to transmission of routines not beneficial for the company. This can happen when groups of people do things in the "same way" when the situations are not really the same.

Obviously, the transfer of skills and habits is far from being a coincidence. In fact, their transmission is generally wanted and arises from the ways people store their roles within the routines. As individuals become more skilled in implementing their parts, the actions are successively stored as procedural memories and can later be triggered as parts of behaviour. So, in general, routines of an organization can be view as concatenations of actions stored within the procedural memory that were firstly generated by a source.

It is possible to give a schematic representation of this mechanism. A first action, labelled with 0, is enacted to an actor labelled with A. His action alters the currents situation so that action 2 is triggered by actor B. C consequently implements action 3, which alters again the situation of B and D. B now gears action 4. D then responds to 3 and 4 with another step and the process continues.



Although the model is not new, and it has been studied by a "neurological" by several authors, in primis by Weick's "double-interact" theory. Indeed, it suggests the presence of a specific mechanism that can prompt the phenomenon of routines, and it provides evidence of its right functioning through the analysis of experimentally-induced routine. Successively,

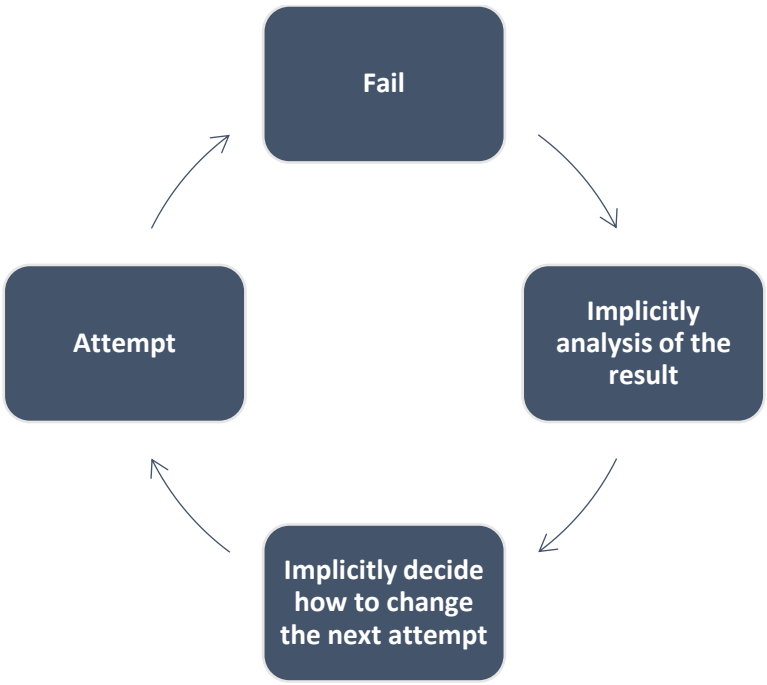
there has been the arising of other experiments about this matter[iv]. This part of the discussion will be reprised in chapter 3.

There have been different models for understanding skill acquisition. The first one was proposed by Fitts (1954) and his colleagues. This model proposed the idea the learning process was formed through the implementation of various stages. The first stage is *the cognitive phase*. At this point, Fitts argues that individuals come to understand how a skill is composed of. In this stage, the desired skill is broken into parts and understanding how these parts come together as a whole for the right formation of the task. The way the whole skill is divided into various pieces is called "schemas". The second stage is called *associative phase*. This stage involves individuals learn the skill and automate it. The third stage regards the *autonomous phase.* The associative phase involves the refinement of the skill acquisition. In this phase, the individual is independent enough to differentiate between important and unimportant stimuli. So, in this phase the studied subject has gained experience and factual knowledge stored for the observed skill.

Successively, Tadlock introduced another alternative that studies perfecting skill acquisition. This model is completely different from the Fitts' one, since in this case the process is formed by repeated actions that are:

- Attempt
- Fail
- Implicitly analyse the result
- Implicitly decide how to change the next attempt so that success is achieved

The stages are repeated over and over again until the learner understands it and remodels the network of actions in a more accurate way. So, this model is less conscious and aware than the other because the patient will end to reach the result by making as many attempts as they are necessary.



Moreover, it has been studied how practice is an important part of the learning process. There is an observed phenomenon known as the power law of learning, which analyses the rate of acquisition over practice time. According to the power of learning law, the learning process follows a faster rate at the beginning of the process and successively tapers off. The power law of learning can be fastened or overcome if the subject is shown a more effective way to complete the task. As an example, a study subject was shown a video showing a task implemented differently by the way he used to do. Although the result had some limits, viewing the film improved his ability of performing it.

Genetic makeup has also found to impact significantly on the skill learning and performance, and therefore it has an important role in achieving expertise. One study examined two groups of people: identical and fraternal twins that were raised in separated homes. The sample analysed was chosen in order to enlighten in the best way the impact of genetic makeup on skill learning, since identical twins share 100% of their genes while fraternal share just 50%. The groups had the task to pursuit a rotor task over and over again. The results showed that the outcomes of the rotor task performed by the identical twins tended to be more or less always the same. While, on the other hand, the results of the fraternal brothers were exactly the opposite: they were disposed to become more disparate over time. In other words, the performance of the identical twins will tend to be closer to 100% identical, while fraternal had a very different performance; that shows how the genetic makeup influences the

difference in skill performance. In conclusion, the study shows different phenomena. The first one is that more practice leads to a closer demonstration of someone's natural abilities (commonly defined as talents). Therefore, some of the differences in the performance among the actors is due to their genetics. Secondly, the experiment confirmed the supposition that practice really improves skill learning.

The last possible framework taken in consideration for the analysis of the processes leading to skill acquisition and routinization was proposed by Cohen through the study of the Mirror Neuron System. This model will be studied more in detail from the second chapter.

1.5.1 The Dorsal Perceptual system

According to Cohen, a second psychological capacity that gives a strong impact on the creation of routines is the so-called action-specialized perceptual capability, that has been labelled in recent years as the *dorsal perceptual system*.

The dorsal perceptual system is usually compared to the ventral system. The ventral pathway plays an important role in the definition of cognitive actions[v]. On the other way around, the dorsal pathway is clearly associated with the definition and preparation of the action. To prove these findings, Cohen studied two types of patients. The first one had suffered specific damage to the dorsal pathway and, as a consequence, although he was able to distinguish the objects by their shape, he could not easily grasp it. Conversely, another patient, who present a damage on her ventral system, was not able to recognize the shape of an object but she was able to catch it if it was thrown towards her.

The dorsal system has a high temporal resolution and is especially performing in the determination of relationships that could exist between objects and events. On the other way around, the ventral system is better in the estimation of spatial resolution and at positions of objects relative to each other and, as mentioned before, is can be prompted more easily consciously.

Contrary to the studies on procedural memory, the ones of the dorsal perceptual system are actually quite new, especially their application in explaining routines. However, the results reached since now are quite promising. Indeed, there has been found a strong alignment of known properties on routines with findings on the dorsal perceptual system in individuals and small groups. Numerous psychologists have argued that the dorsal perceptual system is

responsible for two specific phenomena; the affordance and the anticipation. The former was argued by J.J. Gibson (1979) to be responsible for perceiving a certain product as “sit-able” or “climb-able” relative to how we relate with certain object such as chairs or stairs.

The latter can be considered as a hallmark of action sequences in individual skills and organizational routines. Even in patients with damages to their ventral system, their fingers widen properly to grasp an object long before their hands arrive to touch the object wanted. The same phenomenon can be observed in teams or in working situations. Anticipation permits routines to be enacted very easily and quicker as activities that prepare for a consequent step can be overlapped with a current step, rather than waiting for the starting point of the following step to be fully realized by current action. As it is obvious this mechanism can be risky, since it can lead to superficial behaviours by the implementors within the environment.

So, summing up, new and innovative studies for understanding the dorsal perceptual system will help scholars to gain more insights on the real nature of routines and their formation. However, since there is still a long way to go, this argument will be not faced any further.

2. Routines seen by Human Mirror System's output

As we previously pointed out, the way through routinized behaviours emerge and spread among multiple actors is still an open question. An interesting perspective about this matter is offered by a neuro-cognitive mechanism. Specifically, new studies have been suggesting the existence of a new neural system which has a key role in coordinating individuals with other individuals via imitation of actions. This system is known as *Mirror Neuron System* (MNS)[vi]. The Mirror Neuron Mechanism allows mammals, on the contrary of other animal species, to learn and understand by imitating the others' behaviours.

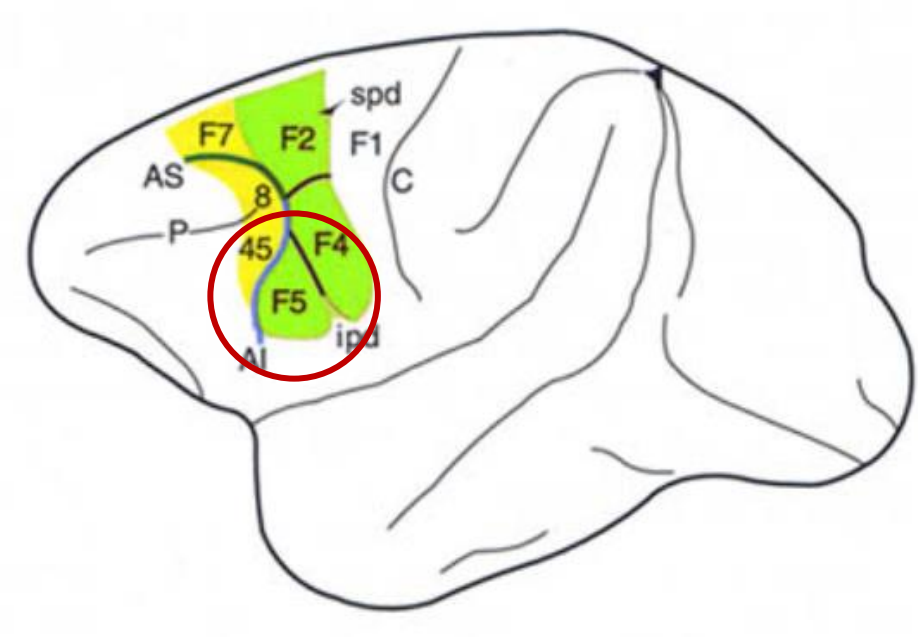
As it is obvious, the MNS is formed primarily by the so-called mirror neurons. These are a particular class of neurones originally discovered in the area F5 of monkeys' premotor cortex, that discharge both when the monkey does a particular action and when it observes another doing a specific action.

The discovery of the MNS can be considered recent. The first studies have been conducted during the '80s and the '90s by the neurophysiologists Giacomo Rizzolatti, Giuseppe Di Pellegrino, Luciano Fadiga, Leonardo Fogassi and Vittorio Gallese[vii]. They discovered the existence and the functions of mirror neurons through an experiment consisting in attaching electrodes in the ventral premotor cortex of the macaque monkeys to see how the neurons placed in that area were responding. The outcomes of this experiment were first sent to Nature; however, the English journal rejected it for its *"lack of general interest"*.

Some years later, the same group published another study on which they argued that the human Broca's area[viii] was the equivalent of the area F5 in monkeys. Both this study and the precedent were arguing how MNs are fundamental for the responsiveness to hand actions. Successively, another study conducted by Pier Francesco Ferrari confirmed how the presence of mirror neurons is also fundamental for mouth actions and facial gestures.

2.1 The Mirror-Neuron System in Monkeys

In the cerebral cortex of monkeys, it is possible to identify two possible classes of visuomotor neurons in the spotted area F5: canonical neurons, which are the ones responding for the presence of an object, and mirror neurons, which respond when monkeys see object-direct action.



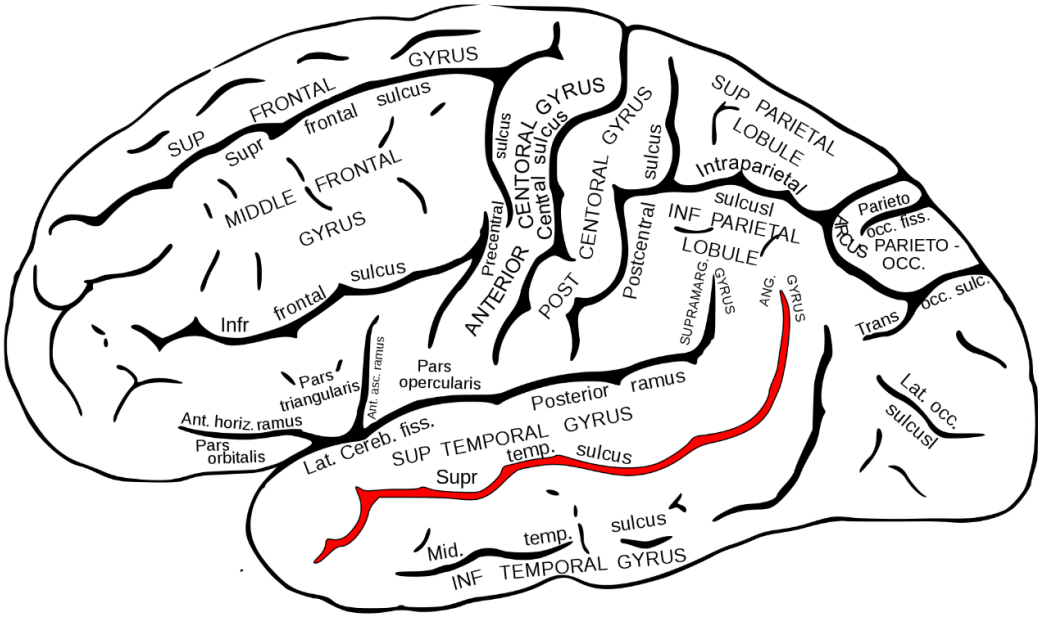
The basic characteristic of the mirror neurons is that they are activated specifically through an interaction between a biological effector[ix], such as hand or mouth, and an object. The sole visualization of the object or of an individual making non-objective directed gestures is unproductive. Mirror neurons work through a large scale of generalization; they can be enacted by different kind of visual stimuli which that can present all the same action. For example, the same action of grasping an object responds both if a human hand and the monkey's hand make it. Similarly, the action is enacted both if the action is done near or far from the monkey. An important operational aspect of mirror neurons is the linkage between their visual and motor properties. Virtually, all mirror neurons show a congruence between the actions they respond to and their motor response. According to this type of congruence, mirror neurons have been divided into two distinct categories: "strictly congruent" and "broadly congruent". The congruence is seen as strict when the observed and executed actions correspond in terms of goal and precision in doing the action and they are about one third of all neurons in the F5 area. On the other way around, broadly congruent mirror neurons do not require the observation of the exactly the same action in order to be triggered and they represent two thirds of F5.

From these analyses, it has been shown that 25% of studied neurons have mirror properties. According to these studies, two types of mirror neurons have been found: ingestive and communicative mirror neurons. The former type replies to action related to ingestion such as grasping food and eating it. Neurons of this nature constitute about 80% of the total amount of the recorded amount of mirror neurons. Generally, ingestive mirror neurons show a good congruence. More precisely, 33% of them shows an identical correspondence between the effective observed and executed action. In the remaining 67%, the effective observed and executed actions are similar or functionally related. Regarding the communicative mirror neurons, their main object is the observation and mimicry of communicative gesture such as lip smacking. However, although their focus is different, the way they act is the same as ingestive mirror neurons.

At the beginning, scientists could not be able to explain the existence of this dichotomy. Successively, they discovered that the real nature of communicative mirror neurons can be explained by seeing them as derived from ingestive neurons evolution.

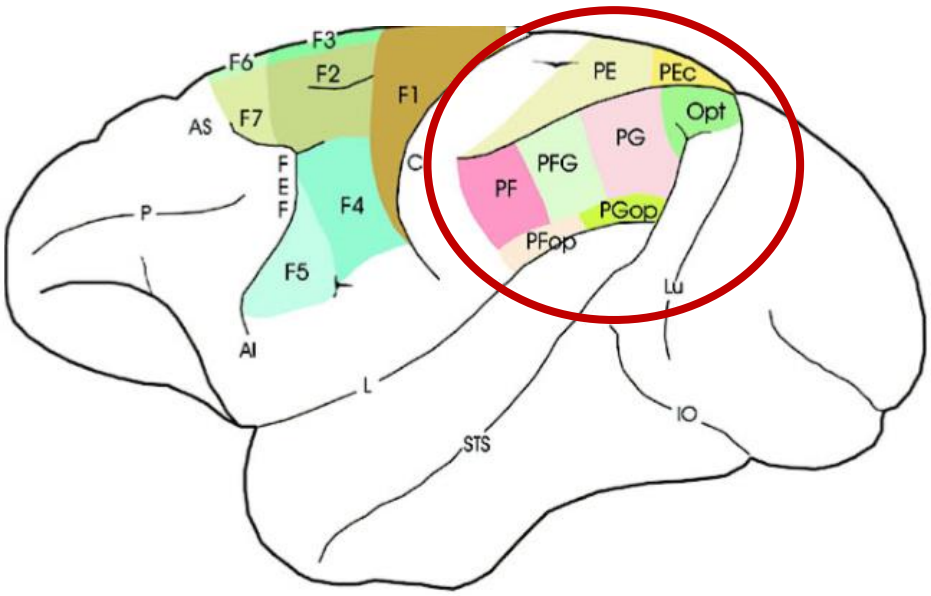
2.1.1 The Mirror-Neuron Circuit

As we said before, early studies on mirror neurons were concentrated on the area F5 of the premotor cortex. However, mirror neurons are not present just there. A region in which neurons with these characteristics have been found is the Superior Temporal Sulcus (STS; the highlighted in red).



The neurons located in this area respond effectively to movements such as walking, turning ahead, bending the torso. Just a restricted group of mirror neurons in this area discharge also during the observation of goal-directed hand movements. By comparing the functional properties of STS and F5 neurons, there are two different elements that must be pointed out. First of all, STS seems to be recognising a much larger number of movements than F5. This can be due to the fact that the STS area can reach, albeit indirectly, the whole ventral premotor region and not only F5. Secondly, STS neurons do not appear to be endowed with motor properties, that means they do not discharge when a movement is performed[x].

Another important area where the neurons have been responding to the observations done by scientists is the so-called 7b or PF of Von Economo.



This area, spotted by the red circle, constitutes the rostral part of the inferior parietal lobule and it is in charge of receiving the inputs from STS and of sending signals to the ventral premotor cortex including area F5. The neurons in this area are characterized by a high functional heterogeneity. About the 90% of them responds to sensory stimuli, but about 50% of them also have motor properties that can be seen when a monkey performs a specific action or movement. PF neurons answering to sensory stimuli can be divided into: "somatosensory neurons" (33%), "visual neurons" (11%), and "bimodal (that are both somatosensorial and visual) neurons" (56%). In all these clusters of neurons, about two thirds of them have mirroring properties.

In conclusion, apart from the area F5 in the ventral premotor cortex, it is possible to identify other two areas of the brain:

- The Superior Temporal Sulcus (STS);
- The PF area or rostral part of the inferior parietal lobule;

However, since neurons in the STS area lack of motor properties, we will not be taking them in consideration any further.

2.1.2 The operational functioning of the MNS works in Monkeys

It is possible to advance two different conclusions. The first one regards the possibility that mirror neurons enact a mechanism of imitation (that will be discussed lately). The second is that mirror neurons are fundamental for action understanding.

Action understanding, although it is a fundamental topic in everyday life, has never been considered interesting and just recently the matter has gained some popularity. Action is a generic term that can describe different phenomena, from grasping an object to more complex activities. By action understanding, Rizzolatti indicates the capacity to achieve a full internal comprehension of an action and then being able to perform it yourself. Broadly speaking, there are two hypothesis that can help to explain why and how action comprehension occurs. These are called *visual hypothesis* and *direct-matching approach*.

The former states that action understanding is actually based on a visual analysis through which the action is divided into different images that are successively linked together. A simple example can be given by analysis very simple action: the grasp of an apple. According to this view, the images collected by the brain would be: the hand, the apple and the movement of the hand towards the apple. These simple elements would be enough to recognise all the action.

The latter view, the direct-matching approach, is far more complex and it is based on the hypothesis that an observer can understand an action just when the same observer is able to map a mental representation of the action in his brain. According to this approach, an action is truly understood just when the motor system of the observer is able to resonate and grab information. By taking again the example of the hand grasping an apple, the same population of neurons that control the execution of grasping an object is also responsible in the observer's motor area. In other words, we can understand an action just because the motor representation of that action is now in our brain.

Apart for imitation and action understanding, the *primary function of mirror neurons is transforming visual information into knowledge*[xi].

There are two basic reasons for which imitation cannot be the primary function of MNS. Primarily, although mirror neurons constitute a revolutionary mechanism that let primates understand actions done by their conspecific, it is not possible to claim that it is the only existing mechanism. The second point regards the way mirror neurons are considered.

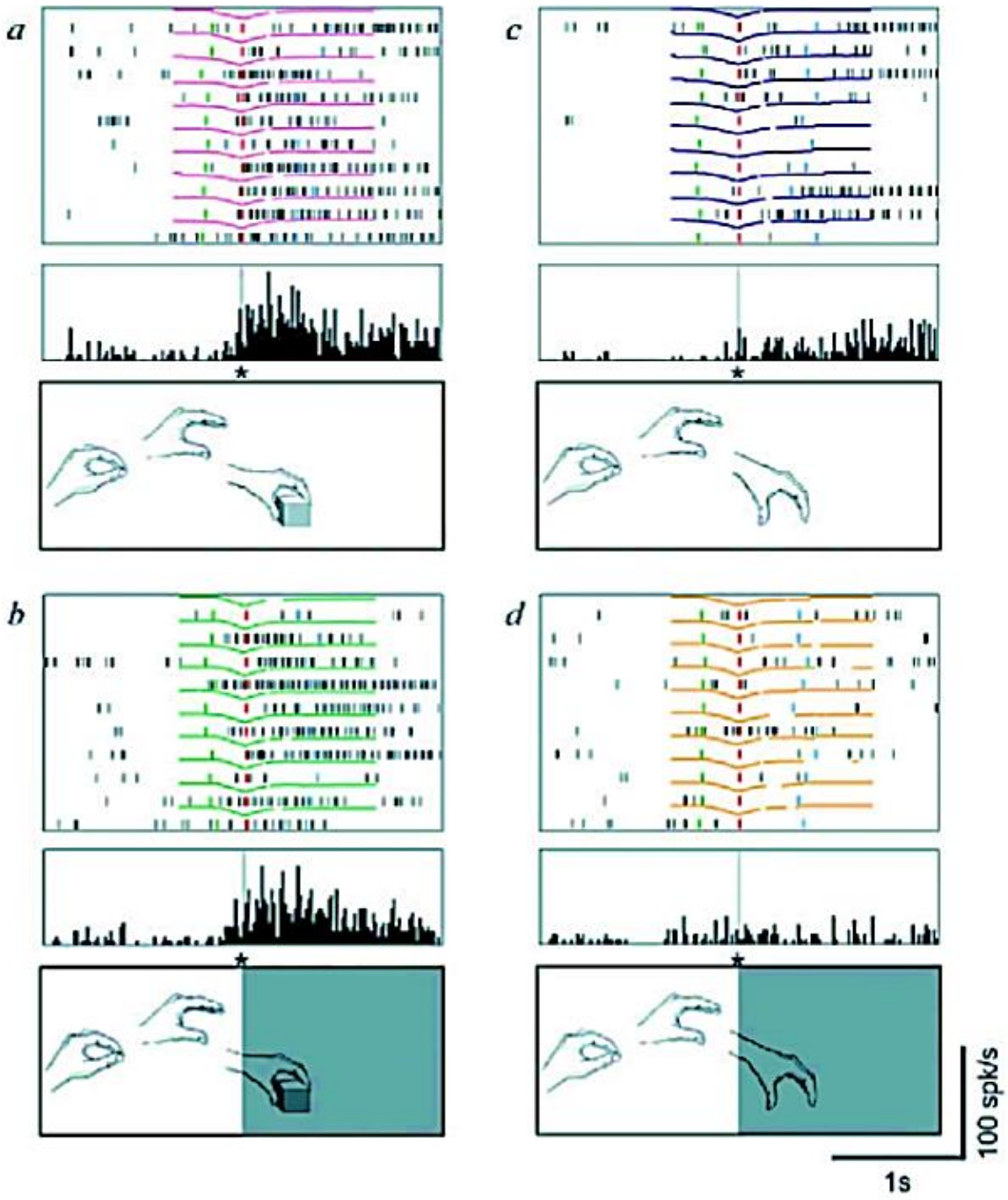
Although laymen are often convinced that imitation is a very primitive cognitive function, they are wrong. Indeed, the ability of imitating, the capacity to learn from coping others' actions can be found only in primates, more specifically, solely in humans and apes. Therefore, the main function of mirror neurons cannot be just acting as enhancers of imitations.

To prove that the main focus of MN mechanism is transforming visual data in knowledge, Kolher et al. conducted two different experiments. The first analyses the case in which F5 mirror neurons are able to recognise actions from their sound, while the second experiment whether the mental representation of an action triggers their activity.

Kolher at first recorded the activity performed by the mirror neurons while the monkey was observing an action accompanied with a noisy sound (such as ripping off a shit of paper) and successively the same sound was reproduced without seeing the action. The results of this experiment showed that about 15% of mirror neurons responsive to presentation of actions accompanied by sound responded to the sound alone.

For the second experiment, neurons were also tested in an experiment in which two different noisy actions that were presented randomly according to different combinations, such as: vision-sound, sound only, vision only, and possible motor conditions.

The reasoning behind these two experiments was involved in action understanding; they should be performed even in the case in which the monkey does not see the action occurring but just hears the sound of it. The neurons were tested in two basic conditions. In the first one, called "full vision" condition, the monkey was shown the entirely visible action. In the second one, that was instead named as "hidden" condition, the monkey was shown again the action, but the most critical part was hidden.



The figure here exposed shows the main results of the experiment that can be divided in A, B, C and D. In figure A, the hypothesis of full visibility is retained. In this case, the neuron illustrated in the figure is responding very actively to the observation of grasping and holding the object. The neuron also is active when the stimulus-triggering features (approaching and grasping an object) were hidden from the monkey (situation B). On the other way around, situation C and D represent the observation of the same mimed action once in full visibility and the other under hidden condition. As a further result, it is possible to see how from a physiological point of view, situation B and D appear to be identical. Therefore, it was the

understanding of the meaning of the observed actions that determined the discharge in the hidden condition.

In conclusion, both experiments demonstrated that the activity of mirror neurons is correlated with action understanding. The visual representation of the action is vital to enact mirror neurons and successively captivate it. If action comprehension is possible on another basis (e.g. action sound), mirror neurons signal the action, even in the absence of visual stimuli.

2.2 The Mirror-Neuron System in Humans

On the contrary of what the majority would think, there is no direct evidence of the existence of mirror neurons in humans. However, it is possible to observe some neurophysiological experiments analysing that when individuals observe a determinated action made by another individual, their motor cortex is active.

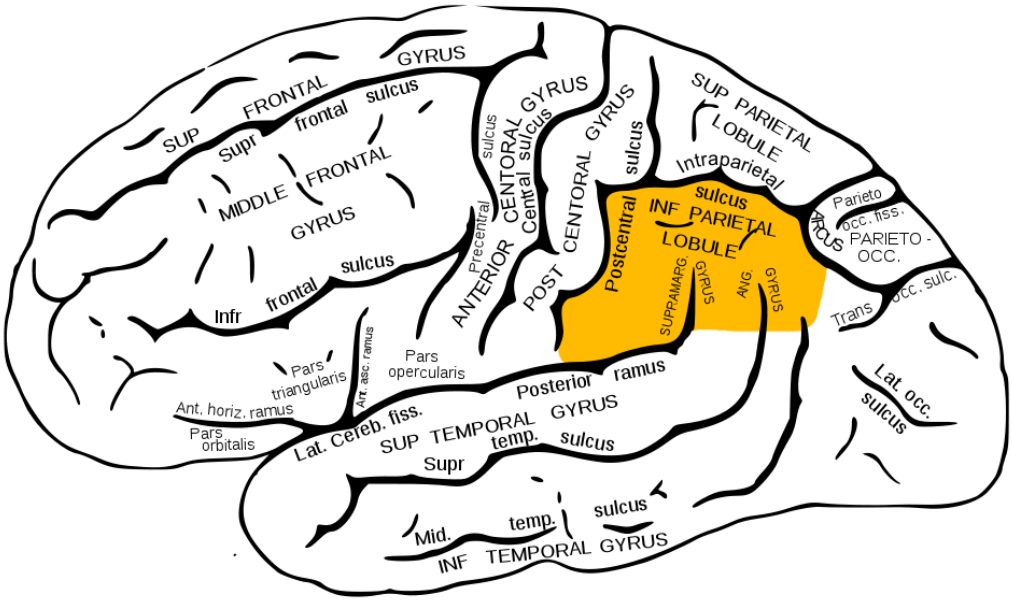
The first example of such studies was conducted by Gastaut and his collaborators in 1950. They detected how the EEG[xii] movements do not follow the so-called mu rhythm not only when an activity is performed, but also when individuals see others doing an action. This result was successively verified by Cochin in 1998 and by Alschuler in 2000.

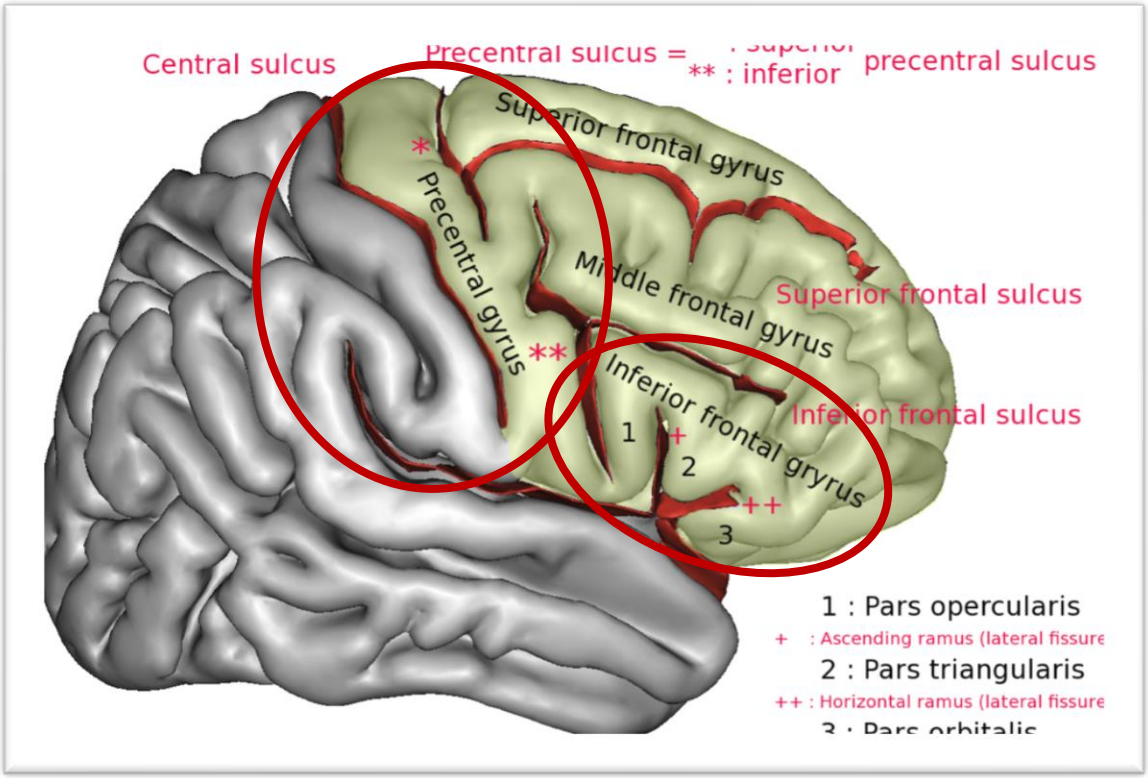
However, the most direct results were found in 1995 by Fadinga through the analysis of *Transcranial Magnetic Stimulation*[xiii] (TMS) studies. This technique regards the stimulation of the motor cortex and it is able to measure motor-evoked potentials[xiv](MPs) can be recorded by the movements of muscles. Successively, the fullness of MPs' attitudes can be used to assess the central effects of various experimental conditions. This approach has been used to study the mirror neuron system. In general, these studies assessed that a mirror neuron system exists also in humans and seems to possess not also the same characteristics seen in monkeys, but also other possible innovative properties.

First of all, it has been shown that also intransitive meaningless movements such as performing no-sense arm gestures, that do not cause any response in monkeys, are detected. Secondly, the excitability registered in the temporal areas of cortex, especially during action-observation, suggests that human mirror-neuron systems code also for movements forming an action and not only for action as monkey mirror-neuron system do. All these properties play an important role in determining the human's capacity to imitate others.

2.2.1 A cross study between monkeys and humans

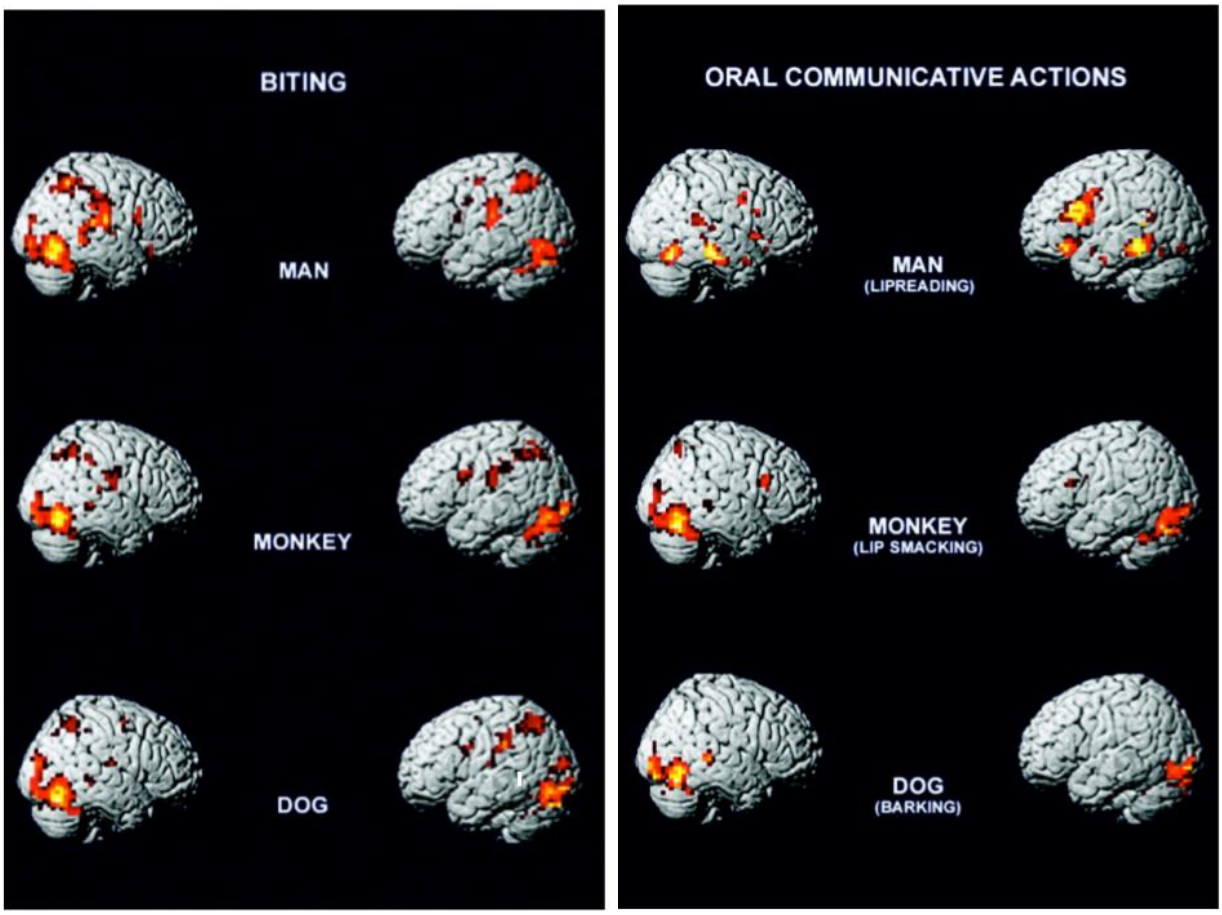
In the previous chapters, we have seen how mirror neurons help both humans and monkeys to copy and understand their similars' actions by seeing them performing them. However, it is vital to point out that there are very big differences in terms of brain constitution among the two species. As it is obvious, many different studies that both the anatomy and the system of actions that is handled by human brain are very complex. The same studied mentioned before showed that the observation of actions done by others activates in humans a network system formed by occipital, temporal and parietal visual areas and other two cortical regions in charge of motor activities. These two last regions, which form the MNS in humans, are: (i) the rostral part of the inferior parietal lobule[xv] and (ii) the lower part of the precentral gyrus plus the posterior part of the Inferior Frontal Gyrus (IFG)[xvi xvii]. As it is possible to see from the picture below, the IFG is formed by three different pars gyri[xviii], rims on the cortex of the brain, which are: the pars opercularis, pars triangularis and the pars orbitalis. Modern studies have demonstrated how pars opercularis is the human corresponding of the F5 of monkeys. Pars opercularis is also called Brodmann Area 44 (BA 44), whose functions are usually performed in the left area of the brain, and it is in charge of the speaking and all semantic activities. Moreover, some recent studies have analysed how it can also be in charge of music perception. The other two areas, pars triangularis and orbitalis, keep being obscure. Although scientists have assured that their role regards the managing of semantic tasks, more precise information are not provided yet.





Obviously, all these differences can sometimes lead to different outcomes. In this context, there have been studies on how some experimental subjects react when they see actions that are performed by more distant species like dogs. In order to respond to this question, a recent fMRI experiment [xix] was conducted using samples of the three species: humans, monkeys and dogs. This experiment was run by showing some video clips which were showing silent mouth actions performed by humans, monkeys and dogs to some volunteers. More specifically, two types of actions were showed: biting and oral communicative actions such as lip smacking, barking etc.

The results are presented through the analysis of static images that showed how, regardless of whether the action was performed by a man, or other animals, the mechanisms that firstly activated were the pars opercularis of IFG and the near gyri. The first results that need to be exposed are the ones related to the action of "biting". The movements of the left rostral parietal focus and the left premotor focus were nearly the same in all the species, where the activation of the foci in the IFG was stronger during the observation of activities implemented by other humans.



Different results were achieved when communicative tasks were accomplished. Speech reading enacted the left part of the pars opercularis. On the other hand, the observation of lip smacking activated a small area in the right and left part of IFG. Finally, barking showed no response at all.

All these results confirmed that actions can be recognized through different mechanisms.

- Actions that can be recognised as motor nature are mapped by the motor system;
- Actions not belonging to this category do not excite the motor system and appear to be recognized on visual basis without enacting any motor coping.

Actually, it is probable that this different way to elaborate stimuli is also due to possible existing psychological counterparts. In the first case the motor resonance translates the visual experience into an internal “personal knowledge”, whereas this is lacking in the second case.

2.3 Imitation

As we previously argued, one of the hypothesized conclusions regard the role of mirror neurons is their ability to allow imitation[xx]. The term "imitation" can be used for expressing different values. In the everyday life, it means solely to copy the behaviours or the actions of others. Sometimes, imitating behaviour is related to be part of a certain environment, allowing the observer to trigger non-specifically, coherent responses according to a phenomenon called "*stimulus enhancement*". However, a more specific definition entails that imitation regards motor behaviours that are determined by the observation of actions enacted by conspecifics. Generally, imitated actions can be characterized by a full comprehension of the original action: by being an approximated replica of the original and it can involve actions never performed by the implementor. Although the majority of the most "classical" ethologists recognise only this type of imitation process, it is true that nowadays the most basic phenomenon characterizing imitation is that which has been defined "response facilitation" (RF). The response facilitation is the automatic propensity to reproduce an observed movement. The greatness of this phenomenon is that it can occur with or without an understanding of the actions performed.

2.3.1 The Response Facilitation phenomenon in detail

As said before, the response facilitation phenomenon can be of different kinds: without comprehension of the action copied or with action understanding.

The response facilitation phenomenon that does not concern the understanding of the original action seems to be an "ancient" unconscious activity that is inner different species. One of the most classical examples is the one regarding the behaviour adopted by birds in case of danger. As soon as an external danger is detected by a bird in a flock, it starts to flap its wings, and consequently the others will see and repeat the movement comporting the flee of the entire group. The real interesting element in this example is that the action performed by the first bird is perceived by the others and triggers a signal for the behaviours of all the other birds, coordinating their behaviour.

If we take in exam human-related examples, the phenomenon of imitation without the comprehension of the action involved can be found also in children and new-borns. A famous case is the one provided by Meltzoff and Moore. The two authors point out the ability of infants to imitate buccal and manual gestures learned by their parents. Although the

learning process of these types of actions result to be fundamental for their development, they do not understand, or just partly understand, the meaning of these actions.

While infants tend to repeat the actions seen by grownups without thinking, adult observes typically imitate the actions performed by others after having comprehended them. There are different motives that can push someone to copy someone else's actions. The first one is for a sort of "symbolism" or "quasi-symbolism", such as social gestures (shacking hands, arm movements to invite someone in, etc.); while, the other group of reasons is related to goal-related behaviours: motor acts and motor actions. This type of distinction actually very logic, but it corresponds to the way in which the motor system is organized.

With motor acts, scholars intend all those movements that are directed towards an object and that allows an effective interaction of the individual in external factors. Examples of motor acts are grasping an object, holding it. While, motor actions regard all those movements, or sequences of movements, that lead to the accomplishment and produce a reward. For example, a typical motor actions may be composed by all the sequences of motor acts performed to allow feeding.

As previously said, the distinction between motor acts and motor actions is also anatomically motivated. More specifically, there are some evidence showing that motor acts are coded by single specifically neurons in the are F5. Similarly, there are neurons in the area F2 and F4 that are in charge of specific movements such as arm reaching. On the other way around, at the moment, is not possible to identify specific neurons or groups of neurons coding motor actions. So, both convincing evidence of presence or absence is still lacking.

So, taking in consideration what we said until now, it is possible to conclude that mirror neurons allow imitation to take place. Moreover, it is possible to distinguish different three sub-mechanisms that form the process of imitation: retrieval of a motor act, construction of a sequence of motor acts, and refinement of the motor act or the motor sequence.

Following the differences in terms in complexity and anatomical features, there are also differences in terms of how the mechanism of imitation is triggered.

Regarding motor acts, usually the mere observation of the phenomenon leads to the activation of the imitation apparatus. The difference between just understanding an act and also imitating it is that, when the act is also copied, the internal adoption of the "know-how" of doing that act is also accompanied by an external representation. However, the aware

repetition of the action can be useless and sometimes even dangerous for the observing individual. Therefore, imitation occurs for social reasoning or as a learning mechanism.

On the opposite, the mechanism for the motor action imitating process is much more complex. A first hypothesis to explain how these actions can be absorbed by the observer is given by Byrne in his discussion of what he calls "action-level imitation". According to Byrne, through this mechanism a spectator is able to copy an action or a behaviour that was not previously in his motor repertoire. He continues suggesting that such behaviour is imitated through a process that regards dividing it in subsegments of simpler components that are in the observer's memory. The MNS would work as an instrument to help to recognise these simpler "strings", that can also be called motor acts, that contribute to form the motor action. Using Byrne's words, the imitation of "motor action" is "reading the letters of action by means of response facilitation, action by action". Although this mechanism does not take in consideration many aspect, it still represents a valid theory to explain the motor actions' imitation and why just humans are able to do it.

Finally, the least aspect that need to be taken into analysis is the capacity to modify a motor act or a motor action that is already present in the observer, so that the imitated behaviour results to be more "personal" to the implementor. This capacity can be very wide and can comprehend different activities from lifting a hand to playing soccer. To reproduce this type of imitation, the implementor/observer must have the capacity to produce what they called a "sensory" copy of the action or act that has been imitated and then compare it with the original. The rationale is that any time a subject generates an action, he produces also a sensory copy that it is consistent with already present models in possess of the subject. If the motor representation of a voluntary action evokes an internal sensory anticipation of its consequences, imitation can be achieved by a mechanism that connects this internal, action-related representation with the representation of visually observed movements that have been imitated, and a subsequent reactivation of the relevant motor representation. Preliminary brain-imaging experiments indicate that this mechanism might indeed exist in humans.

2.3.2 Proves of human innate capacity to imitate

Human capacity to imitate each other is essential to comprehend the environment around us as well as social different social behaviours. Although, in the last two decades our knowledge about the mechanism of imitation and its sources has spread significantly, there are still some elements that need to be clarified. More specifically:

- If human capacity to imitate is innate or not;
- Along with that, if it is also a human capacity to comprehend when someone has been imitated;
- How is it possible for a human to understand the ideas/beliefs behind the behaviour of imitation;

To do so, we need to look at the researches made by Piaget in 1962. According to his view, it is possible to see first episodes of imitation from the first year of life. Piaget argued that new-borns associate themselves with others through a mechanism of mirroring game and tactile exploration of their own and others' faces. One study, as previously briefly mentioned before, helped to highlight this imitative capacity. This study, conducted by Meltzoff and Moore, demonstrated that 12-21 days-old children[xxi] were able to imitate four different adult gestures: lip protrusion, mouth opening, tongue protrusion and finger movement. The results showed that the infants were able to identify the four movements and to distinguish the body parts involved. It seems like infants know which part of the body to move and how to move them. Meltzoff and Moore call this phenomenon "organ identification".

They also describe a model of infant facial imitation. According to this model, humans' learning process is based on a primitive and latent "body scheme" that permits infants to act in accordance with the environment around them. This body scheme is actually a "supramodal" representation of the observed act (it consists in the same concept of direct-matching approach). This type of representation allows children to gather the information and use them successively.

Human beings are not just able to imitate, they are also able to understand when they are imitated. Such reciprocal mechanism, as said before, is basic for social and communicative exchanges. Parents use also a technique of imitation, although unconsciously, to establish intersubjectivity with their preverbal infants.

During the '90, Meltzoff also conducted experiments to test whether also the capacity to understand to be imitated is innate. To do so, he tested if children were capable to recognize when another individual does "like me" and the consequent emotional experience. One first trial was centred on 14-month-old infants and two adults. One of the adults imitated everything the baby did; the other imitated what another baby had done. Each adult copied one of the infants, so each acted like a perfect baby. Could the infants distinguish which adult was acting just like the self?

The outcome was positive: each child was able to understand which of the adults was coping them. They looked longer to the imitating adult, they were smiling at them etc. Further researches also helped to discover that there are significant differences in the way a younger and an older infant can react. Although a younger infant is able to recognise the action and the subject that is copying, he cannot modify his own action in order to see whether will be copied once again. For example, if an adult systematically matches a young infant's movement, that movement attracts the attention of the child, but he will not switch to another to test the relationship. Conversely, an older child treats this interaction as a game and he will tend to change the movements that are communicated. This indicates some kind of evolution that goes on between the older infant and the adult. That is why older infants would joyfully engage this kind of "game" for twenty minutes or more. The children can distinguish themselves from the others and it also looks like they start to recognise, although basically, the sense of an agency relation – exploring who is controlling the situation and who is not.

After having demonstrated that humans not only are able to imitate but also to recognise whether they are imitated, there is another question that must be analysed: in the case of an external observer, how can he recognise the "original" and the "imitator"?

Decety built a PET[xxii] study to register this phenomenon. Through PET analysis, there were analysed two different imitation conditions: the subjects were asked or to imitate the experimenter's actions or to see their own actions being imitated the experimenters'. On these two assumptions, three controlling conditions were used:

- the subjects were free to move as they wanted and to use any object they wanted (this condition was called action-generation control);
- subjects just had to watch the experimenter performing (observing action control);
- the subjects were asked to perform some actions while watching some other person simultaneously performing mismatched activities (visual-motor mismatch control).

From the PETs, it was possible to see that there were several regions of the brain involved in the two imitation conditions compared to the control conditions, namely the STS, the inferior part lobule, and the medial prefrontal cortex.

Through all this analysis, it emerged that all the areas forming the MNS and its associates were operating in different ways:

- The medial prefrontal cortex was the area responsible to be activated in tasks involving mentalizing;

- The tasks of the inferior part lobule were diverse. In particular, the left part was activated when subjects imitated each other, while its right homologous was associated with being imitated by others.
- The right STS area is involved in visual analysis of the others' actions while the left part was concerned with the analysis of the others' actions in relations to the ones performed by the self.

However, humans are not just sacs of flesh and bones that imitate and are imitated. Behind these behaviours there are their intentions, ideas, and beliefs. Recently the attention has moved towards understanding the process of decoding thee goals and intentions of others. To do so, Meltzoff introduced a new type of experiments characterized by a higher level of proactivity based on using imitation in a more abstract way. These new sets of experiments explore toddlers' capacity to read the underlying intentions of an actor.

One study was about showing to infants of 18-months-old a failed action. More specifically, an adult had to "accidentally" over-undershot his target and thus the goal was not achieved. For an adult it is easy to comprehend that it was an unsuccess and the task was not reached, but is it possible for a child to see that? To measure if and how the toddlers were able to interpret the event correctly, Meltzoff analysed how the chose to react. It the case they would have chosen to reproduce the task in the correct way, it means they had an understanding of the real intention was.

The study compared children's capacity to perform the target act in different situations.

- After having seen the act fully completed;
- After they saw the experiment performed unsuccessfully;
- After it was neither shown nor tempted;

The outcomes showed that that 18-months-old toddlers could conclude that the action was a failure and what the real goal was. Both infants who saw the unsuccessful attempt and infants who saw the full goal acted to reach the correct target with a good degree of control. So, in conclusion, young children could distinguish what the goal is. Even when they were shown the failure case, they chose to imitate what it was supposed to be. This developmental research shows that infants distinguished between what the adult meant to do and what he

actually did. This recognition between what it should be and to do lies at the core of our mentalizing, and it underlies our moral judgments. The infants in these experiments were already exhibiting a fundamental aspect of our adult framework: the acts of people are construed in terms of goals and intentions.

3. The Experiment

Since now, we have been studying what routines are, their main characteristics and various theories on how they get a form. Now, we focus our attention on one of them: the Mirror Neuron System. From now on, the focus will be on the experiment conducted to prove that MNS has a basic role in the constitution of routines. To do so, we have been taking as principal root for the construction of our study the experiment called Target The Two (TTT) previously conducted by Cohen and Bacdayan in 1994.

3.1 Aims of the Experiment

Although most of the scholars would concord that routines are more visible through field observation, it is undeniable that, at least for certain aspects, they can be efficiently studied by starting from psychological premises with the help of laboratory methods. Cyert and March began to formulate such studies in their *A Behavioural Theory of the Firm* where they presented many classical experiments with the aim of inducing and identifying many differentiated and interlocking patterns that can be classified with the term routine. Accordingly, our aim in this case is to provide that routines are in some way enacted by the Mirror Neuron System and that they are successively stored as procedural memory that, as we pointed out in the first chapter, can be defined as "*that form of memory that stores the components of individual skilled actions for both motor and declarative memory*".

As a first step, it is vital to recall that our procedures will have to generate patterns of behaviour e laboratory showing with the four main characteristics of field-observed routines: (i) reliability (the increased ability of the organization to produce a good result); (ii) speed (routines make procedures generally faster than average); (iii) repeated action sequences (usually routines are composed by the same sequences of actions or habits); (iv) occasional suboptimality (although they lead to a general increase of efficiency, there are some case of suboptimality that may happen). Through the experiment, we want also to emphasize how these features can be seen all over the experiment procedures.

3.2 Methodology

In this section, our aim is to describe the methodology used in our experiment. Methodology consists in all the actions that must have been undertaken to investigate the research problem. More precisely, the instruments used to collect or generate data and how they were analysed. In our case, the study is a combination on qualitative and quantitative research since it was based on the employ of a card game. This result to be a good field for the experiment, because

it requires a problem solving approach as well as a good amount of rationality and, in the meantime, there is room for routine to form. To start, we designed the experiment by taking into analysis two factors: Action and Routine. Successively, we developed two different levels for each factor. More precisely, in the former case, we have chosen to analyse the Observation, so to undergo the test in a situation in which the members of the sample could see each other moves, and the Hidden level in which they could not see the others' moves. For the latter, we have tried to take in consideration an approach that enhances routinization, by giving to the test the same task to complete (Formation). In the other case, the aim was trying to obstruct the formation of the routine by always changing the task to be completed (Obstruction).

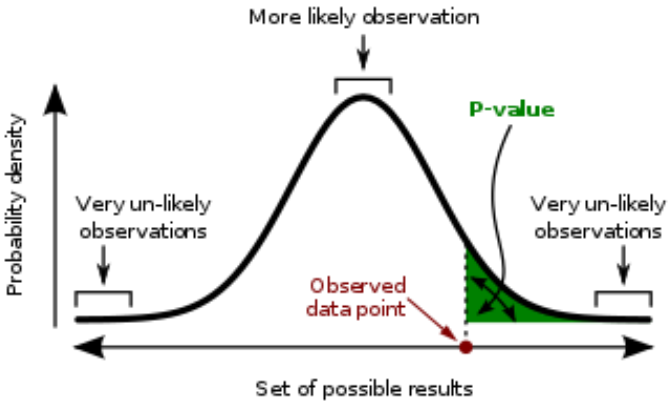
Experimental design:

- 2 x 2 between-subjects' design:
    - **Action:** observation vs. hidden;
    - **Routine:** formation vs. obstruction

The experimental task is between subject: it means that each group of subjects is submitted to just one condition. When the experimental tasks are between two subjects, it is possible to use the ANOVA Factorial Analysis. ANOVA is the short-term for **An**alysis **O**f **Va**riance. Its main purpose is to test if two or more groups differ from each other significantly according to one or more characteristics. A factorial ANOVA relates averages across two or more independent variables that split the sample in two or more groups. The ANOVA uses the *F* test, which means it allows scholars and researchers to compare different groups even though group means differ. The *F* test is the ratio of two independent variance estimates of the same population variance. We decided to consider an alpha test of 0.05. Consequently: the F-value will be rejected if, after counting the degrees of liberty, the F-value results to be larger than the critical F-value. On the other way around, the F-value will be considered acceptable if it is smaller than the critical F-value.

Obviously, it is possible to analyse whether the hypothesis is acceptable or not by considering the p-value (as we have done). By comparing the p-value with the alpha test (α= 0.05), we indicate that there is the 5% of risk of concluding that a different exists when there is no actual difference.

Below, it is presented a graphical representation of the of the p-value and of the degree of liberties.



A **p-value** (shaded green area) is the probability of an observed (or more extreme) result assuming that the null hypothesis is true.

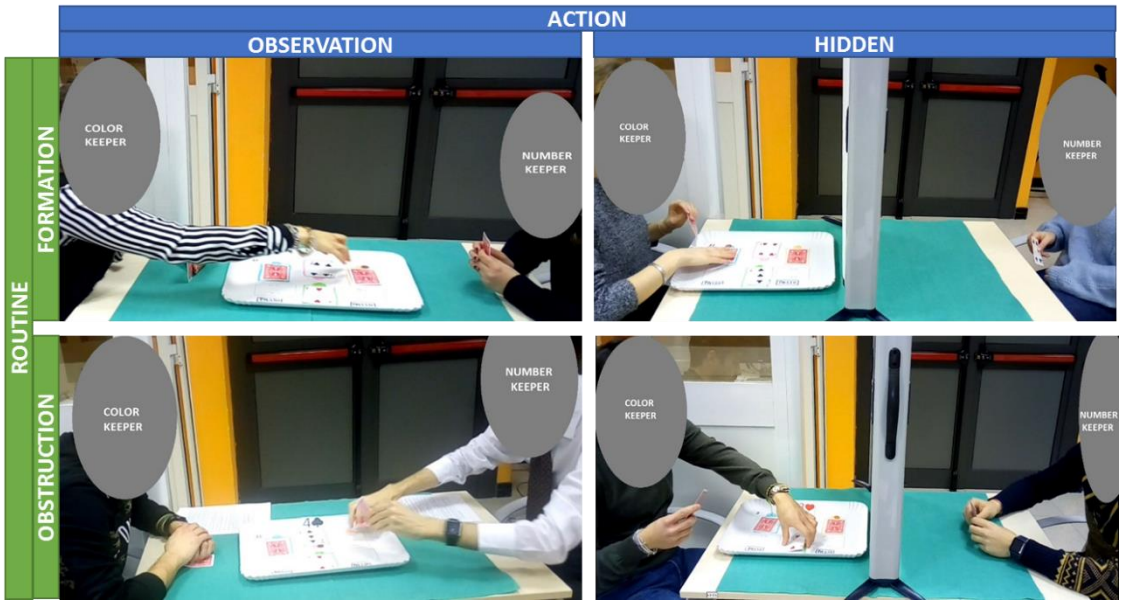
So, if:

- P-value $\leq \alpha$, the differences between some of the means are statistically significant;
- P-value $\geq \alpha$, the differences between the means are not statistically significant;

Since two factors are considered, each of them with two levels, there are in total 4 conditions possible given by the combination of the four. These are:

- Formation – Observation: this is the easiest condition. The sample is subjected to always the same target and they can see each other moves;
- Formation – Hidden: in this case, the target remains the same for all the game, but the two of them cannot see the other's moves;
- Obstruction – Observation: the routines is obstructed, the target changes at every hand, but the players can see each other;
- Obstruction – Hidden: this is the hardest possible state, the goal to reach changes every time and a panel is placed between the two in order to cover the other's moves;

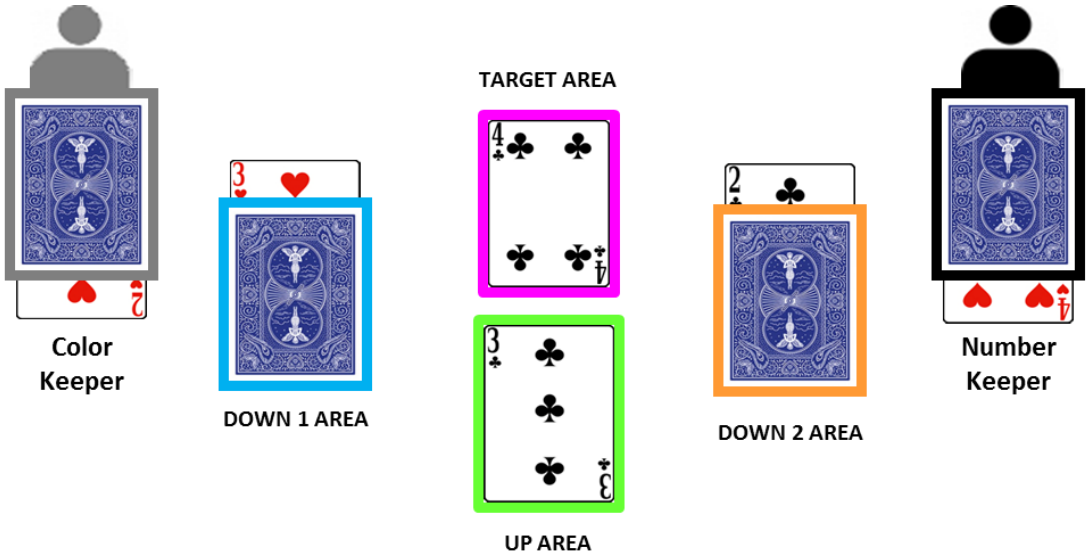
In the image below, it is possible to see the graphical representation of the four conditions put in place on the samples taken.



Regarding the sample, we randomly took 82 participants. In this group of participants, there were 46 males and 36 females with an average age of 23.56 with ± 1.86 Standard Deviation. The group is formed by a group of graduate and upper-level undergraduate students in business, public policy, and the social sciences grouped into 41 pairs. All-male, all-female, and mixed-gender pairs were allocated as evenly as possible into the four experimental conditions. Assignment to partners, game roles, and conditions was otherwise random.

3.3 The Starting Paradigm for the Study: The Target the Two (TTT) game

As said before, The Target the Two (TTT) is a card game invented by Cohen and Bacdayan to explain the concept of routinization. The game is played by two gamers using six cards: the 2, the 3 and 4 of red hearts (respectively 2 ♥, 3 ♥ and 4 ♥) and the 2, the 3 and 4 of clubs (so 2 ♣, 3 ♣ and 4 ♣) that are disposed as follows:



Since there are six hundred legal ways to deal the cards in the game, this kind of environment creates a task setting with an important property: routines can form because the hands are similar, but each hand is unique in its own way at least in some respects.

As it is possible to see form the graph, the game field is composed by two uncovered cards, respectively the Target Area and Up Area, and other two face-down cards that neither player can see. Moreover, each player can see their own card and have to respect some "role" that represents their restriction on moves. The player on the right, called "Colour Keeper", may move and exchange cards with the target area just the constrain of the colour of the card is respected. The player on the left, on the other hand, is called "Number Keeper" and may exchange with the target only if the card is representing a number.

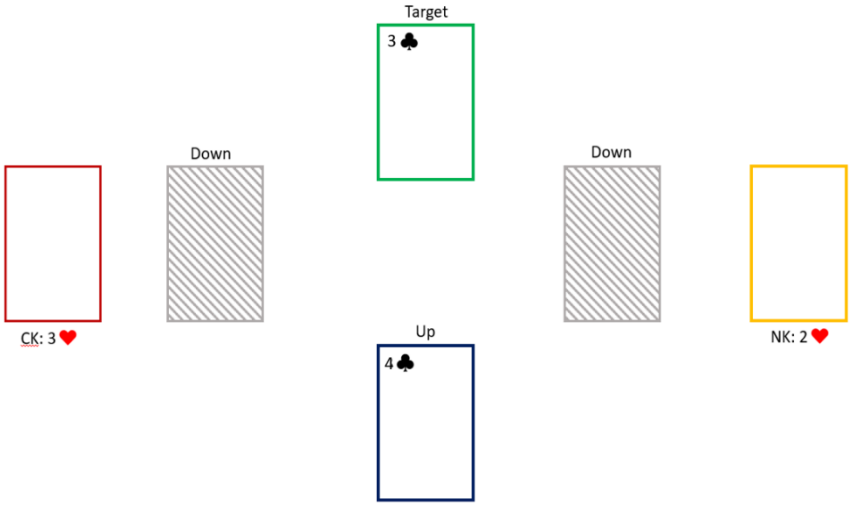
In the original version of the game, the main objective was trying to put the 2 ♥ into the area target. However, in our version, this is only a part of the game.

Indeed, the aim of placing the 2 ♥ in the T area is maintained in the case in which the games are held in a condition of Formation (in the cases where the target is always the same). In the cases where the condition of Obstruction is held, the target always changes. This basic modification of the goal to reach is done to test the capacity of the individuals to reach an

efficient and sustainable level of routinization. As we will see later, this change has important effects for routine.

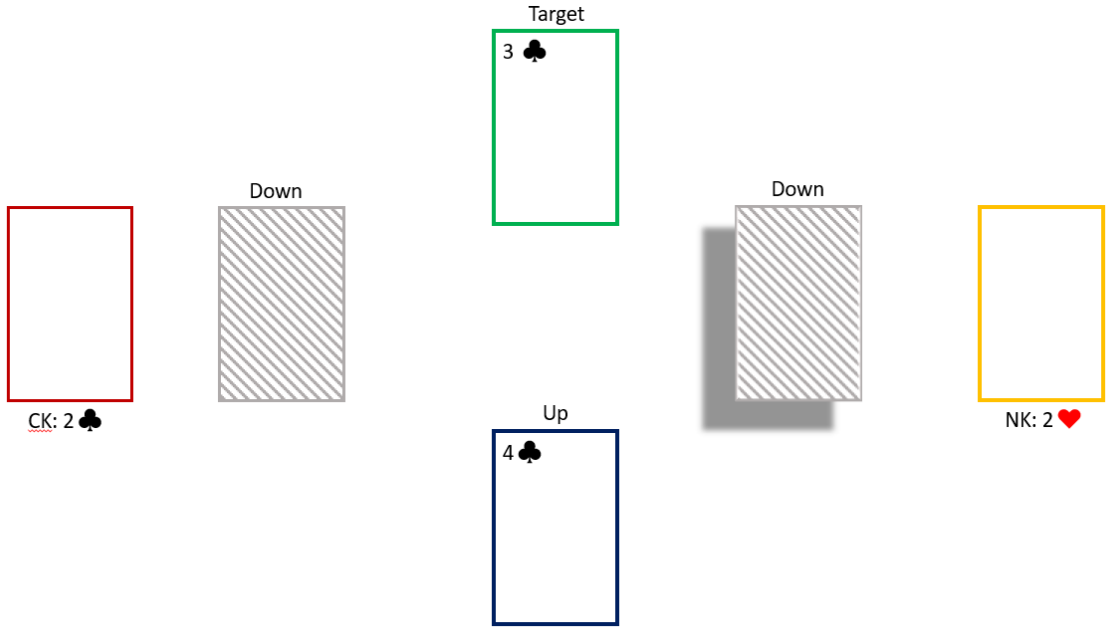
To start, to each group it was shown an example to train them to the rules of the game. For simplicity, we are going to the describe solely the trial for the simplest case "Formation – Observation".

The first situation is the following:



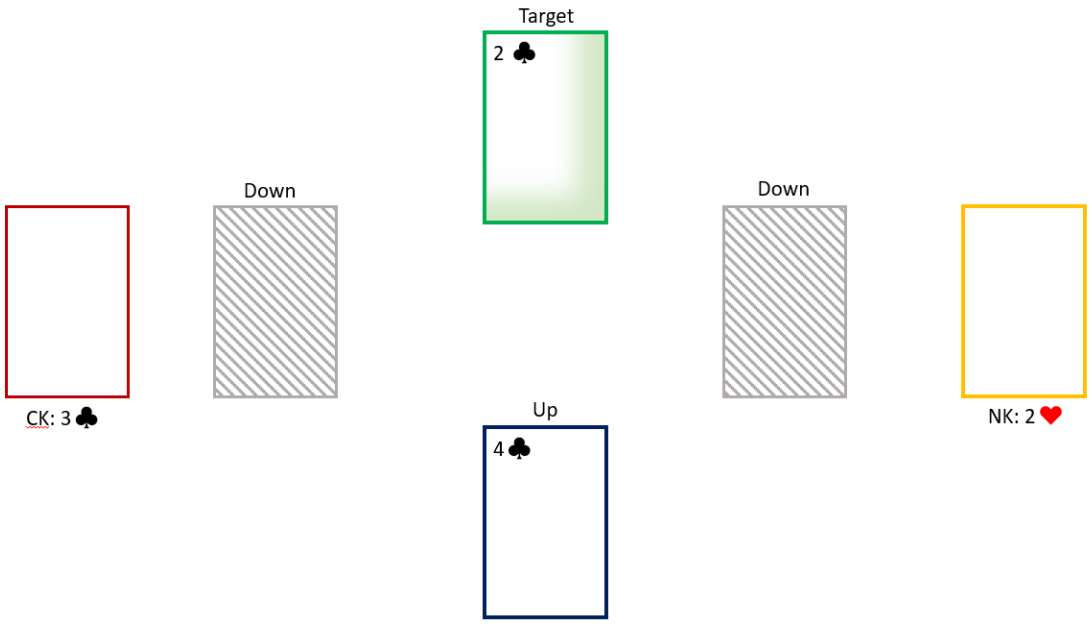
As it is possible to see from the figure, in this case the Colour Keeper has a 3 ♥ while the Number Keeper has for now a 2 ♥.

In the next figure, the Colour Keeper, that always moves as first, exchanges his card for the down card at the upper left of the figure that contains the 2 ♣. His old card, 3 ♥, has replaced to the other's place without being seen by the other player.



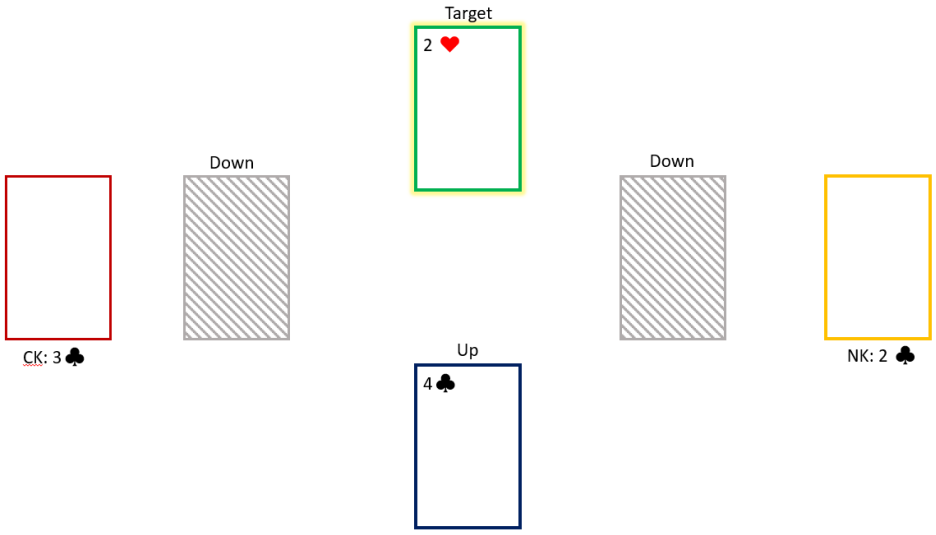
Now, it is Number Keeper's turn. He would like to put the 2 ♥ in the Target Area, but he is constrained to exchange cards just when the numbers are preserved. So, he has four possibilities: exchange with the Up card; exchange it with one of the Hidden cards; or just pass. In order to favour victory, he is advised to just pass. Since no move has actually been done, no image is shown.

Now it is again Colour Keeper's turn. Since the colour in his hand and in the Target area is the same, it is legal for him to change the card with the one 3 ♣.



The Number Keeper can now legally exchange his card with the target, which produces the situation following: The task has been completed in 4 moves.

The incentive system in our experiment was that the samples had 40 minutes to finish all 40 hands of the game. To each hand they completed successfully they earned 1 €, while they lost a dime of 60 cents for each move made (including passing). At the end of the 40-minutes session, the two participants split their winnings equally. Consequently, the two subjects have a good incentive to work cooperatively and to try to maximize their efficiency. On the other hand, it created tension between the two performance measures: the teams need to work together to finish as quick as possible in order to increase the number of hands.



At the same time, they need to play carefully in order to avoid unnecessary moves to complete the tasks.

The experiment was designed to be representative of organizational life by taking in consideration series of important constraints. The colour and number constraints are fundamental for the creation asymmetry of capabilities and thus the potential for division of labour and distinctive roles.

Regarding the possible problems in which the players can occur, there have been episodes of failure of coordination asymmetry that can lessen the total performance in a way that is even worse than what could have been achieved by the two playing alone. Due to the presence of the hidden cards, hand cards and, in some cases, also due to the presence of the panel and the change of the target to search, there is also uncertainty and asymmetry of information.

As each group plays, they build their own scheme of game that reflects their ways of thinking as single people and as a team. Their learning process creates an organization, although it is small and short-lived.

After the trial, to each group was given a written copy of the rules of the game. The conditions regarding the time available and the rewarding mechanism were kept the same for all the groups. However, as said before, we imposed different types of manipulations to the original game (Formation – Observation; Formation – Hidden; Obstruction – Observation; Obstruction – Hidden).

A part for the classical version, we imposed to the $^1/_2$ of the participants that they had to play without being able to see each other's moves. We used a panel to impede the two players to look at the others' moves and to act in accord.

To the other $^1/_2$of gamers, we imposed the condition of modification of the target to find. Instead to look for the 2 ♥, the target used to always change.

Finally, according to the last condition of the game the two individuals had to play being separated by the panel and the target was always changing.

Subjects were strongly advised not to talk during all the process, both between sessions and not talking was allowed during the play. The experimental sessions were videotaped. The resulting recordings were then processed through different programs, such as Solomon Coder[xxiii], used to record every moved played and to calculate the time spent to do the move. The method was to watch each hand, recording the moves made, then watch each hand again, making a computer keystroke at the moment each card was realised onto the playing board.

3.3.1 Statistical Testing

Successively, we turned our analysis of the experiment into data to show whether the MNS actually plays some kind of role in the constitution of routines.

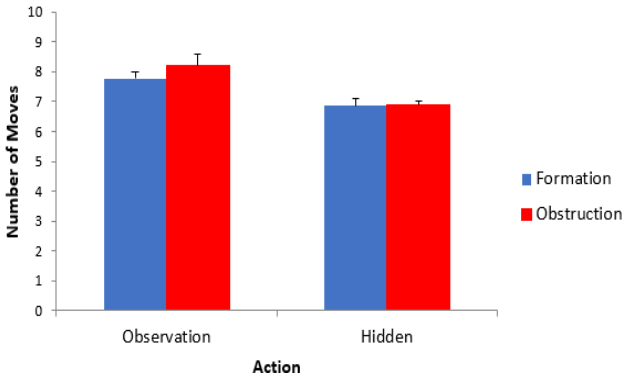
All the studies were conducted by using the ANOVA Factorial Analysis since there were just two factors involved.

From this starting point, it is possible to have three kinds of information:

- The effect of the Action (whether it is under the condition Hidden or Observation);
- The effect of Routine (by studying both the hypothesis of Formation and Obstruction);
- The interaction between Routine and Action;

The first type of evaluation was made by analysing the Number of Moves: so, the number of moves used to complete each hand.

Number of Moves: Factorial ANOVA → Action (Hidden vs. Observation) by Routine (Formation vs. Obstruction)



Univariate Tests of Significance, Effect Sizes, and Powers for N of Moves - Sigma-restricted parameterization - Effective hypothesis decomposition								
	SS	Degr. of Freedom	MS	F	p	Partial eta-squared	Non-centrality	Observed power (alpha=0,05)
Intercept	4529.30	1.00	4529.30	3039.72	0.00	0.97	3039.72	1.00
Action	24.90	1.00	24.90	16.71	0.00	0.18	16.71	0.98
Routine	1.12	1.00	1.12	0.75	0.39	0.01	0.75	0.14
Action*Routine	0.75	1.00	0.75	0.50	0.48	0.01	0.50	0.11
Error	116.22	78.00	1.49					

By looking at the F-test and to the p-value, it is possible to see that:

- For the Action: $F_{1,78} = 16.71,\ p < 0.05,\ partial\text{-}\eta^2 = 0.18$;
- For Routine: $F_{1,78} = 0.75,\ p = 0.39,\ partial\text{-}\eta^2 = 0.01$;
- For interaction Action*Routine: $F_{1,78} = 0.50,\ p = 0.48,\ partial\text{-}\eta^2 = 0.01$;

From this data, it appears to be clear that both Routine and the Interaction between Action and Routine are not significant. While, on the other hand, the only effect that is significant is Action. What does it mean? It means that independently by the application of the Obstruction or the Formation condition, the performances have almost an equivalent number of moves made.

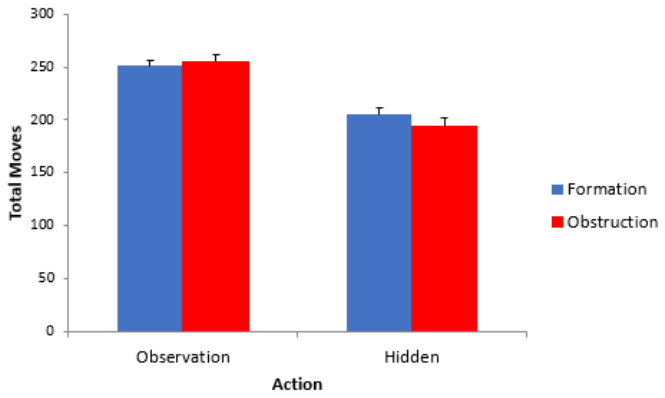
However, on the other hand, if we look at the two conditions Observation and Hidden, it is possible to see that there is a good difference. Indeed, in the case of Observation (the two actors can look to each other's moves), both in the case of Obstruction and Formation, the average amount of moves made in each hand result to be higher than in the case in which the moves were covered by a panel (Hidden).

Although against all odds, this result is very interesting. That means that, on average, the moves made by those who can see each other are less accurate than the other couples. Nevertheless, on the other hand, even if it is true that the moves are less precise, they result to be faster during the game.

So, in conclusion, they unconsciously renounce at being as accurate as possible for more velocity.

For the second case, to the evaluation of the game and the experiment moves to a broader point of view. Indeed, the second evaluation was made by analysing the total number of moves needed to conclude the game.

Total Moves: Factorial ANOVA → Action (Hidden vs. Observation) by Routine (Formation vs. Obstruction)



Univariate Tests of Significance, Effect Sizes, and Powers for Tot Moves Sigma-restricted parameterization - Effective hypothesis decomposition								
	SS	Degr. of Freedom	MS	F	p	Partial eta-squared	Non-centrality	Observed power (alpha=0,05)
Intercept	4184974.00	1.00	4184974.00	4112.36	0.00	0.98	4112.36	1.00
Action	58159.00	1.00	58159.00	57.15	0.00	0.42	57.15	1.00
Routine	252.00	1.00	252.00	0.25	0.62	0.00	0.25	0.08
Action*Routine	1118.00	1.00	1118.00	1.10	0.30	0.01	1.10	0.18
Error	79377.00	78.00	1018.00					

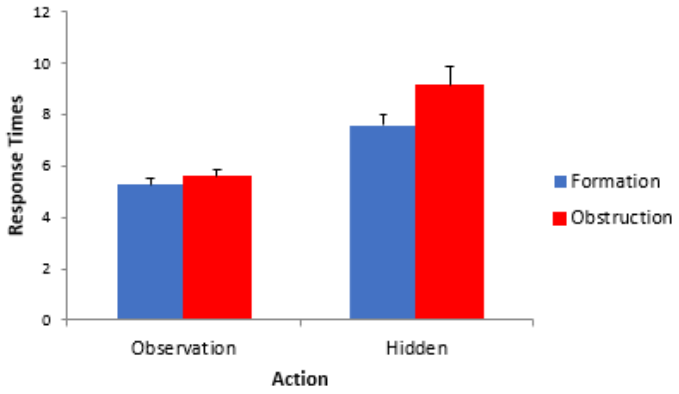
Also in this case, by the analysis of the data:

- For the Action: $F_{1,78} = 57.15,\ p < 0.05,\ partial\text{-}\eta^2 = 0.42$;
- For Routine: $F_{1,78} = 0.25,\ p = 0.62,\ partial\text{-}\eta^2 = 0.00$;
- For interaction Action*Routine: $F_{1,78} = 1.10,\ p = 0.30,\ partial\text{-}\eta^2 = 0.01$;

From these parameters, it is possible to see that also in this case the Routine and the Interaction between Action and Routine are not significant. Still, Action is significant with a $p < 0.05$. So, also in this case both in the case of Formation and Obstruction, there is, on average, the same number of moves made. And again, between the two conditions Observation and Hidden, it is possible to see that there is a good difference.
So, in general, we have seen that the results found by taken in consideration the total amount of hands played during the 40 minutes are the same as before.
In conclusion there are more proves of a trade-off between velocity and accuracy.

For the third evaluation, we took in consideration the Responses Times, which means the time needed for each to play their move.

Response Times: Factorial ANOVA → Action (Hidden vs. Observation) by Routine (Formation vs. Obstruction)



Univariate Tests of Significance, Effect Sizes, and Powers for RT Sigma-restricted parameterization - Effective hypothesis decomposition								
	SS	Degr. of Freedom	MS	F	p	Partial eta-squared	Non-centrality	Observed power (alpha=0,05)
Intercept	3862.26	1.00	3862.26	884.72	0.00	0.92	884.72	1.00
Action	177.12	1.00	177.12	40.57	0.00	0.34	40.57	1.00
Routine	17.97	1.00	17.97	4.12	0.05	0.05	4.12	0.52
Action*Routine	8.10	1.00	8.10	1.86	0.18	0.02	1.86	0.27
Error	340.51	78.00	4.37					

In this case, we have that:

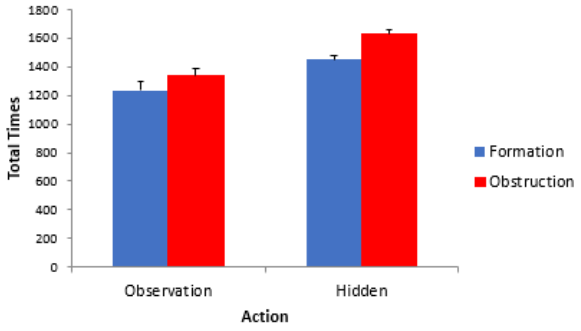
- For the Action: $F_{1,78} = 40.57,\ p < 0.05,\ partial\text{-}\eta^2 = 0.34$;
- For Routine: $F_{1,78} = 4.12,\ p \leq 0.05,\ partial\text{-}\eta^2 = 0.05$;
- For interaction Action*Routine: $F_{1,78} = 1.86,\ p = 0.18,\ partial\text{-}\eta^2 = 0.02$;

There are two effects that result to be significant: Action, as always, and Routine. The positive effect of the Action still indicates that the individuals under condition of Observation need more moves to complete the hands. Indeed, it is possible to see that the difference in terms of averages of the Response Times for Observation-Formation and Hidden-Formation is not significant. This result is still valuable for the Observation-Obstruction and Hidden-Obstruction conditions. Routine, on the other hand, is marginally significative since p= 0.05. In the Observation condition, there is no a big marginal between those under Formation and Obstruction. On the other way around, in the Hidden condition, there is a strong difference in the time response between the easier condition (Formation) and the harder (Obstruction). That means that, in general, those under condition of Formation

are faster movers than those under Obstruction condition. However, although this effect is particularly visible under the Hidden conditions, it is worth also for the Observation.

Finally, the last index to evaluate the experiment was the Total Time.

Total Time: Factorial ANOVA → Action (Hidden vs. Observation) by Routine (Formation vs. Obstruction)



Univariate Tests of Significance, Effect Sizes, and Powers for Tot Time Sigma-restricted parameterization - Effective hypothesis decomposition								
	SS	Degr. of Freedom	MS	F	p	Partial eta-squared	Non-centrality	Observed power (alpha=0,05)
Intercept	#########	1.00	#########	3358.75	0.00	0.98	3358.75	1.00
Action	1320099.00	1.00	1320099.00	27.19	0.00	0.26	27.19	1.00
Routine	401707.00	1.00	401707.00	8.27	0.01	0.10	8.27	0.81
Action*Routine	26199.00	1.00	26199.00	0.54	0.46	0.01	0.54	0.11
Error	3786892.00	78.00	48550.00					

However, it is important to specify that this is not the all 40 minutes that are set as. As a matter of fact, this is the time calculated by estimating the reaction time that was need to each player to do his/her move. So, for summing up, it is the "game time".
By looking at the F-test and to the p-value, in this case we have:

- For the Action: $F_{1,78} = 27.19,\ p < 0.05,\ partial\text{-}\eta^2 = 0.26$;
- For Routine: $F_{1,78} = 8.27,\ p < 0.05,\ partial\text{-}\eta^2 = 0.10$;
- For interaction Action*Routine: $F_{1,78} = 0.54,\ p = 0.46,\ partial\text{-}\eta^2 = 0.01$;

It is possible to see that the Action is significant, so the hypothesis that who is able to observe the other's action is faster is confirmed. The Routine returns to be significant meaning that those under Hidden condition tend to develop a Routine later than those that can see each other.

3.4 Results

From all these data, it is possible to confirm the initial hypothesis: those who are able to observe themselves are also able to develop in a faster and in a more efficient way a mechanism of routinization.

As a matter of fact, it has been proven that this process of automatization was faster in those who were able to see each other regardless of which level we were considering (Formation or Obstruction); so, the real difference was between the condition of Observation and Hidden. Obviously, we are not saying that those under Hidden condition were not able to develop a routine, but the process leading to its formation was delayed so much that sometimes it resulted to be useless for the reach of the game's goal.

Successively, there have been proves of the existence of the so-called "Speed-Accuracy trade-off" experienced by our participants when they were performing the game. It was possible to see that all the gamers under the Observation condition tended to be faster than those under Hidden condition. However, as a drawback, they were also less accurate than the others. This was due to the fact that the former group was able to form a routine faster than the other and consequently the majority of its action were not reasoned. The group under the Hidden condition, on the other hand, was not able to form this automated mechanism and every move made was the result of a longer reasoning. As a result, they were more accurate but slower.

Such lack of speed was, in general, the reason why they tended not to complete the 40 hands in the 40 minutes allowed in the game. Therefore, they were less efficient than the others.

In the last two evaluations taken, both referred to time, this type of trade-off is visible also by the Formation and Obstruction level, showing that those under the Formation condition were faster and more efficient. However, this result is just slightly significant and visible just by taking in consideration the time played (due to the fact time is a much more sensible variable that the hands played).

3.4.1 Evidence about the characteristics of Routines

At the beginning of the chapter, we listed a series of features that arise when routines come in play. These are:

- reliability (the increased ability of the organization to produce a good result);
- speed (routines make procedures generally faster than average);

- repeated action sequences (usually routines are composed by the same sequences of actions or habits);
- occasional suboptimality (although they lead to a general increase of efficiency, there are some case of suboptimality that may happen).

Indeed, thanks to the experiment, it has been possible to see that, in general, these 4 characteristics were displayed.

Reliability. Reliability can be assessed by analysing the variation across the various pairs in the number of moves made to complete the task. Obviously, there might be some difficulties over the game and this might alter the result. However, over the course of the 40 hands the moves-per-hand required by the pairs to complete the tasks got increasingly similar.

Speed. The second indicator is speed. In order to examine this indicator, we can easily take in consideration the time used in making a move in any hand of the experiment. As we have seen, it is undeniable that during the course of the 40 hands the groups tended to get faster and faster. However, as we saw before, an important drawback was the arise of the "Speed-Accuracy trade-off" for which players could play faster than normal, but not necessarily this behaviour could lead to solutions in few steps. As it is possible to get from the previous discussion, it is consistent with the formation of routines that speed increases over time.

Repeated Action Sequences. Our third indicator of the formation of routines is the development of repeated action sequences. During the game, subjects experience a process during which all reasoned thoughts were transformed into "chunks" of activities that are run off as units. During the process, it is possible to see that different of these "chunks" form according to the best characteristics of the couples. One of the commonest pattern is the so-called "up-up-anything-target" or abbreviate "UU*T". As suggested by the name, this is a sequence that starts by taking the card and exchange it with some other card that is not the in the Target area. The other "U" indicates that the other player does the same. The third element of the sequence indicates that every move is allowed. Finally, the fourth step is the exchange with the target area.

Occasional Suboptimality. The final remark regards the probable suboptimality that may occur during the game. Indeed, this type of phenomenon is due to the fact that routines also involve a certain degree of "institutionalization" and therefore individuals tend to be stuck

in specific lines of though. In other terms, action is made without full deliberation. Although in the majority of times it is an advantage, because of the outstanding reduction in terms of time spent, it might be a problem when the reasoning must be changed.

3.4.2 Evidence that routines are stored in procedural memory

Until now, we have shown that routines emerged during the experiment and that those routines had the four typical features discussed above. Now, there is another question that deserves an answer: are routines or habits, along with all what they concerned, stored in the procedural memory or are they stored in the declarative memory? However, before demonstrating it, we need to recall that declarative memory, that type of memory that is in charge of long-term storage memory that regards facts or events, is slower that procedural memory. As demonstrated by Singley and Anderson (1989), in general individuals are quite keen and quick in answering to mathematical and logic stimuli such as problems or calculus when they are familiar with them. Nevertheless, they result to be slow when novelties are introduced (e.g. a new type of expression or programming a new type of structure). The two continued arguing that individuals, to understand and to adapt novelties, need to switch from skills stored in procedural memory to propositional knowledge stored in procedural memory. To verify that this line of though fits, we need to look at the structure of the experiment itself and the manipulation we introduced.

As we said before, we have introduced two main types of manipulations that, in the end can affect in the process:

- Obstruction: the goal is not always 2 ♥ but it changes in each hand;
- Hidden condition: the two subjects forming the sample are divided by a panel that does not allow to see each other's moves.

Consequently, if we follow Singley and Anderson's assumptions, then we should expect that *those under the Obstruction condition would be slowed by this novelty*. During the studies, we have shown that the subjects under condition of Obstruction indeed had more difficulties than the other groups, especially during the first hands during which they spent more time to complete the hands. However, the groups were also able to rapidly adapt and to speed up in a way that was comparable to the one of the "Formation" groups. So, we might conclude to say that there was a small delay, but, from a statistical point of view it was not significant. On the other way around those who were in a difficult situation and had experienced a very strong delay were the ones under the Hidden condition. Consequently, we can easily

conclude that the modification of the task was not the real obstacle for an efficient resolution of the task, and that those who found themselves in a situation of disadvantage were actually those under the Hidden condition.

As a result, we have demonstrated that the only type of memory that plays an important role during the game is the procedural one; while, the declarative memory has a marginal or non-existing role in the matter.

3.5 Summary and Discussion

All over this chapter, we have at first described the experiment and successively we have shown how, during the procedure, it has been possible to encounter in behavioural patterns that exhibit the main characteristics of organizational routines. Moreover, all the manipulations introduced in the game confirmed what was expected before during the design of the game. In general, it has been possible to certificate all our hypothesis with a good degree of certainty: it has been possible to demonstrate that the Mirror Neuron System unifies in the same neural mechanism a variety of phenomena that ranges from elementary behaviours to higher cognitive functions, such as imitation learning and action understanding. In conclusion, the MNS has indeed a good impact in facilitating the formation of organizational routines aided by the storage in the procedural memory. This result, that after all this study seems to be obvious, is actually very interesting for the successive results and develops that it might enact. About this matter, Cohen and Bacdayan identified different fields of interest in which a further understanding of routines could be incredibly helpful.

Since routines pattern so much organisational life, a good understanding of this line of research could be very significant for managers in order to better understand their possibilities as well as their limitations. For example, by studying in more detail the theme of the understanding and encoding of some social routine, practitioners might be able to comprehend the difficulties that may arise when individuals have to articulate them. Or again, by focusing on the social and cultural background of a sample of individual, we might analyse if some external factors can influence in the constitution of routines.

Another possible contribution may regard the reduction of chances of the kind of inappropriate “firing” of routines that might be present in real life. An example of this kind of “firing” is an employee into a media company that misspell the name of the brand in an

advertising campaign. Although it is not possible to completely eliminate such phenomena, there is room for further develop instruments and devices that can help to reduce them.

Managers can also find interesting focusing on the matter of all the issues lined with the transferring of procedural knowledge across different modules, such as written and verbal forms. This actually points out some real problematics in the everyday life of organizations. Written rules frequently fail to regulate in the best way the employees of an organization since they may not be the best way to propagate the practices of an organization. On the other way around, it is possible to see that, some implicit habits/routines can be more effective than some written rules of the organization. Therefore, studying in this field may help to explain findings about organizational learning such. As an example, General Motors learned less from circulating reports on its NUMMI[xxiv] joint venture than Toyota did by making its managers to move across plants (Krafcik, 1989).

Another issue to face regards the "resistance to change" that is a direct consequence of routine. One possible explanation for this type of behaviour is that routines are located in a very specific and hidden part of the procedural memory. In particular, Argyris and Schön suggest a specific technic that give rise divergences explained in their work Theories in Practice (1974). This theory explores the concept of organizational learning by taking in consideration a very elaborate framework that tries to understand the cognitive structure and processes of problem solving undergoing in people's mind. According to the two authors, theories can be of two genres. The first one is called "theories-in-use" or "theories-of-action". This type of theories is described as "*vehicles for explanation, prediction, or control*". All the theories in this field are based on an underlying set of values, beliefs that sets individuals' perception about the world around him, which include assumptions about the desirable result in different fields. So, according to Schön a theory of action can be described as "*A full schema of a theory of action, then, would be as follows: in situation S, if you want to achieve consequence C, under assumptions a1,….an, do A".* The second one consists in reality in theory of action's special case called "theories-of-practice". This type of theories that comprehends routines, procedures and specific practices for dealing with problems that can be found in the everyday life in organizations. They are described as follows: "*A practice is a sequence of actions undertaken by a person to serve others, who are considered clients. Each action in sequence of actions repeats some aspect of other actions in the sequence, but each action is in some way unique"* (Houchens & Keedy, 2009). A theory of practice is a set of interrelated theories of action that are specific for each

situation. A part for these two definitions, the Theories in Practice suggests that making individuals more aware of their current practices may help them prolificate in more efficient way. This concept has been largely exploited in different experimental works to improve legal testimony or technics in contemporary systems of "quality management".

In the previous chapters, we have been seeing the distinction between procedural and declarative memory. Thanks to this study, it has been possible to understand important features of organizational memory such as that routines are generally stored into the procedural memory. We also saw how this storage entails that information-handling routines is in some way limited since finding/recovering old reasonings or practices seems very difficult. Recognising this strong defect is a good start to develop successive study to improve, as much as possible, the ability of individuals to remember all the procedures that are routinized.

Another study that should be taken in consideration regards the field of cooperative and non-cooperative coordination. Egidi and Narduzzo (1996) started by the TTT game to emphasize how the members of the teams form important bounds based in action coordination. The two scholars analysed how indeed routinized team action offers advantages to end in an efficient way the task if a certain degree of flexibility is permitted. Egidi and Narduzzo stress the importance of routinized behaviour but also the many drawbacks that may arise. As a matter of fact, the standardization of action coordination may reduce the amount of ambiguous and irrelevant information that may stand up at various levels of the coordination. As they show, in certain situation particular actions may assume different "meanings" for different people and, a complex mental framework might entail different problematic strategies; consequently, a more schematic or simpler scheme can be helpful to reduce useless ambiguities.

One last interesting study may regard the other cognitive functions that are enacted by the Mirror Neuron System. One aspect that seems interesting is the link between language understanding and routines. Because the MNS is multi-modal, the scholars Zarr, Ferguson and Glenberg demonstrated that the process of repeating some sentences over and over again would help not only in increasing action perception but also increases language comprehension.

Although we still lack a satisfactory comprehension of the precise role of the mirror system in these functions in many cognitive capacities, the MNS seems to offer a new and very

promising heuristic tool for their empirical investigation. It can entail different studies concerning different variables that can help effectively to improve organizations' agenda and framework.

4. Routinized Group Behaviour: a broader approach to the TTT experiment

In the last section of the previous chapter, some successive studies and experiments that took inspiration from Cohen's work regarding the formation of organizational routines have been presented. One of the most interesting approach was espoused by Nicolao Bonini and Massimo Egidi in their work *"Cognitive traps in individuals and organizational behavior: some empirical evidence"* (1999) in which they used the Target The Two experiment to study two phenomena that will be explained below. In their work, they start analysing the behaviour adopted by Barracudas in some situation of danger noticing how their ways to react is quite similar to the ones arising in a context of teams of human beings in a context of routinized behaviour. In particular, they note that barracudas' attacks adopt some specific ingredients that scholars identify as typical of *routinized group behaviour*:

- *Repeated action*: as we saw in the previous chapters, a main characteristic of routines is that they consist in individuals that follow mechanically a list of instructions. This is particularly true for a those under the same environmental circumstances;
- *Condition-action rules determine the routine execution*: most of the fishes observed show a prominent lateral line on each side of their body on which it is possible to observe the presence of displacement-sensitive receptors. It is possible to demonstrate that these receptors have a prominent role in guiding all the members of the school as they were all following a plan;
- *Distributed coordinating devices*: along with the condition-action rules that draw the routine, it is possible to see that, for a good execution of the routine/plan, there is in general the presence of some kind of devices that enacts routines. In cases of fishes, Partridge argues how important vision and the lateral line on their bodies generate important and distributed information the pattern collectivistic behaviours. So, in conclusion, the evidences show that behavioural rules are generally simplified and decentralized;
- *The variety and suboptimality of escape patterns and the selective pressure effect*: as we had the possibility to demonstrate above, when routinized behaviour are in play, there are some episodes of suboptimality.

Although it sounds odd, the choice of taking as a starting point the performance of fishes was actually very keen. As a matter of fact, in organizational context the majority of company's know-how is tacit, and therefore it is not easy to stand out the part of knowledge that belongs specifically to an individual or to the organization. An initial point of Egidi and

Bonini's analysis is to understand according to what criteria a set of subjects decide to act as a unit. To do so, the analysis will concentrate on two different approaches of relations that may incur in a team and that, ultimately, lead to the final decision. These are respectively: shared mental models and group/team mind.

Successively, a second aspect strictly related to the former is presented. It is about the so-called "cognitive traps" already suggested in 1988 by Levinthal and March. The two authors suggest that in organizations, there might be routines that result to be valid in the short-run, but they are very disappointing in the long-run. Companies may not be able to recognise these traps and to respond in the most efficient way possible. Specifically, the biggest issue in organization regards the case in which these traps are caused by the inability of human beings to explore new strategies of action, when environmental conditions change. Based on these assumptions, the chapter will concentrate on two aspects that can allow the team to overcome these obstacles, respectively: Flexibility and Cooperation. The demonstration that these two aspects are essential for the effectiveness of a team and of routinized behaviours will be given by analysing Cohen's game Target The Two (TTT).

4.1 The Concept of Team and Coordination

Decision making processes as well as implementing plans of action usually involve the use of coordinated and interdepending activities typical of a team. Although in the past scholars have used indifferently the term group and team, there is actually a strong difference among them. Namely, teams are usually formed by a diversified group of individuals with a strong level of differentiation of the skills and the knowledge owned. Moreover, main characteristics of teams are their high level of cooperation, reciprocal adaptability and a common belief for an ideal. Usually teams are formed by groups of experts. On the other way around, groups take form on similar and interchangeable elements and show a very homogeneous level of knowledge and skills. The two groups are also distinguishable because of the tasks they do. In general, teams do tasks that could be undertaken solely by an individual, but they are handled by subjects that, all together, possess an important expertise. A good example of team is, for example, the ones for clinical operations or military command unit.

During the study on organizational routine, it has been discovered the presence of the so-called behavioural variables. Glickman et al. (1987) reported two different types of

"variables" which tend to emerge and spread during the work of the team. On one side, these behavioural variables may be caused by an individual that has to perform the task (two subjects can have two different approaches to the same problem). On the other side, there is the behaviour that places an actor in relation with the environment or with other individuals in the group. A possible example of such phenomenon is communicating a message. More in detail, it is possible to see some of these variables entail important consequences such as: the flexibility of team action and coordination of team members.

Researches on team decision making is indeed very recent. The most recent and updated studies, such as the Target The Two experiment, generally rely on trainings or experiment that describe the actions, decisions and communications that take place in high skilled groups performing complex tasks. Although several theoretical and practical experiments have been done, there is still so much to discover about organizational routines' nature. In particular, the specific skills characteristic of the decision-making activity of an efficient team and also the processes involved in the acquisition and the maintenance of critical skills has been studied just partly. However, in the last few years, two decision making approaches have been developed: the one's of shared mental models, and the second one regards team mind or group mind.

In the former case, the main idea is that team performance improves if the members of the group have the identical understanding of the task that must be performed. In general, shared mental models may include different dimensions, such as:

- Task-specific knowledge;
- Task-related knowledge;
- Knowledge of teammates;
- Attitudes/beliefs of the members;

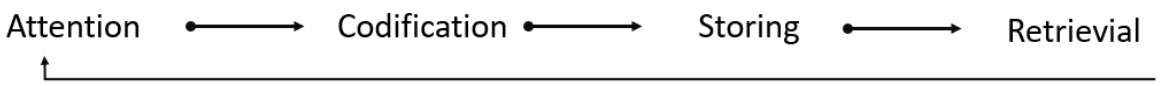
In the latter case, there is no a real common line of thoughts that is followed, but the decisions taken by the group are actually formed by a series of information-processing phases that lead to a common result.

As a matter of fact, it would be more correct to define the two as "approaches" rather than "theories". However, they account various phenomena evident in team behaviour and also provide both a conceptual framework for use in analysis of team decision-making and interesting indicators for future studies. According to the approach of shared mental problems, coordination among the members of a team, and their ability to exploit it in the

best way, depend on the ability to share mental models relative to a specific situation. Mental models consist in organized frameworks of knowledge relative to the situation that the team has to deal with, such as skills that must be possessed or procedures to use. Usually, some of this knowledge derives from the membership of the team or the cultural or social background such as the belonging to a certain category of professionals (surgeons have a different expertise and routines of managers in a company). Putting in place a shared knowledge facilitates communication helps to harmonise the function of the team and to work as a single unit instead of an aggregation of separate entities. According to this approach, the rocks of its foundations are generally two:

- Reciprocal and precise expectations, concerning the various aspects of the situation and the goal that must be reached;
- The development of a series of shared explanation. It is fundamental for a group having the possibility of benefitting some solid explanations or previous knowledge that could make its member understand why and for what reason they act like that;

On the other way around, the approach of the group mind or team mind is not based on the assumptions of some general and shared framework of skills or resources, rather it works as a continuous exchange of members' contributions that successively are elaborated through various information-processing phases. Rather than being a relatively logic and rational process, it is actually biased and very similar to how people's minds work in case of decision-making. More specifically, Duffy recognise different phases of this course that can be summarised as follows:



As it is possible to see by the draw, the process is quite immediate. The information at first must catch the attention of the observer (in this case the team), successively they are codified in a language that is understandable and stored for a successive use. Finally, they are recuperated and use as much as it is possible. The procedure is not ended, the gathered information can be analysed over and over again and modified as a consequence. Obviously, as it happens for humans, this process is not risk-free and can be disturbed very easily by external factors such as company's background or human capacity to store all the information.

In 1993, Klein proposed a new model that states that both team decision-making and individual decision-making are characterized by a process called "recognition-primed decision making". According to this model, decision-making process, both referred to both types, is strongly influenced by individuals' past experiences to verify whether the current situation analysed belongs to an already-known category. Generally, the most viable decision is made by taking in consideration this type of categorization but there are some aspects that must considered such as a possible modification of the plan due to successive re-evaluations.

4.2 Flexibility through the TTT game

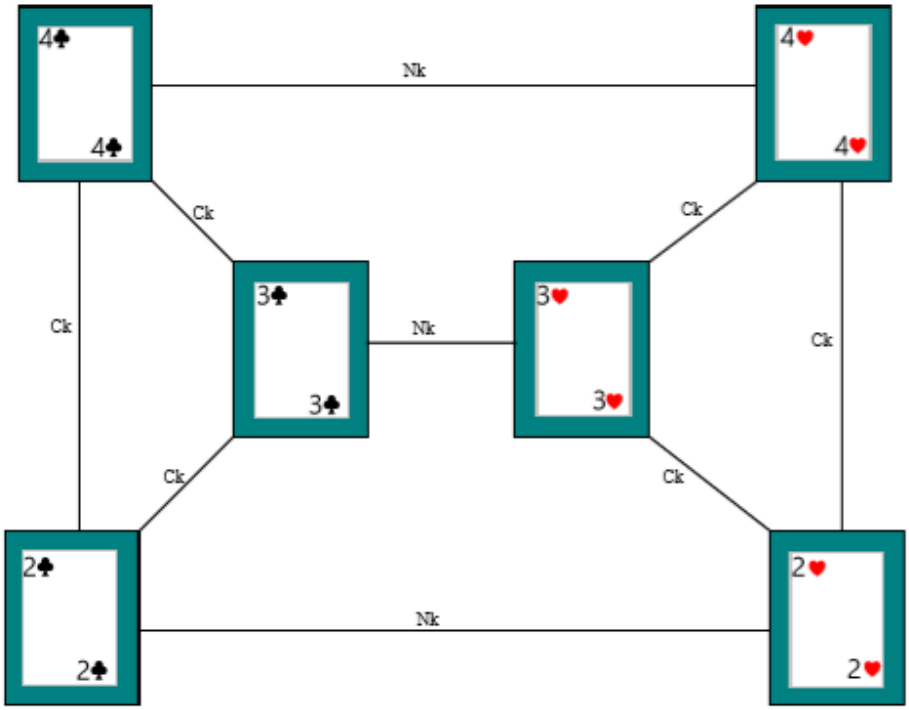
The first issue to face, as previously mentioned, regards flexibility. Flexibility is an important competitive advantage for a team since regards its ability to adapt more rapidly to changes in the environment and in the conditions in which the team operates. For example, a team may have also to deal with problems arising by being unfamiliar with each other or there might be problems unknown until now. Despite the importance of such themes, they have been just slightly studied and there is just a little evidence on the learning mechanisms connected with flexibility/rigidity. One of the most important studies is the one proposed by Levinthal and March (1993) stating that the same features that may lead a company to success may also be their doom. Although it seems peculiar, they analyse the concept of "successive trap", a procedure or an instrument that resulted to be effective for reaching success, but it becomes deleterious if it is used over and over without adaptation. The organization may enter a vicious circle which damages its overall performance. According to the two, this phenomenon seems to vary in risk according to the characteristics of the company and of the process in exam. Generally, however, it is particularly exacerbated by the use of procedures used repeatedly in the past but that run the risk of becoming obsolete.

Egidi and Bonini analysed the problem of rigidity/flexibility that may incur in teams by using their own version of the experiment Target The Two card game in which the conditions are the same as the original:

- 40 hands in 40 minutes;
- 60 couples constitute the sample of study;
- The roles of Number Keeper and Colour Keeper are still valid;
- The target is always the same: placing the 2 ♥ in the Target Area;

- The two in the team cannot talk to each other;

Since in the previous chapter, we have examined the TTT game quite scrupulously, it is possible to jump up to the conclusions obtained by the two scholars. By analysing the game, it has been reassumed all the moves that are possible for the Number Keeper and those that the Colour Keeper could do that are all represented in the graph below. In general, the Number Keeper could move solely by following the horizontal lines while the Colour Keeper by the vertical and oblique lines.



According to these movements, it has been possible to detect two different strategies that if we are in a condition in which, in the beginning, in the Target area there the 3 ♣ or 4 ♣. These are:

- The 4 ♣ 4 ♥ 2 ♥ strategy: in this strategy, the Number Keeper is the leader of the game because he first acts by placing the 4 ♥ and by letting the Colour Keeper finish the game by placing the 2 ♥ in the Target Area;
- The 4 ♣ 2 ♣ 2 ♥ strategy: here the Colour Keeper is in charge of managing the strategy because he first puts the 2 ♣. Consequently, the Number Keeper can conclude by putting 2 ♥ in the Target;

The two strategies resulted to be both very efficient and led to the same result (placing the 2 ♥ in the Target), consequently they could be used with the same degree of discretion. However, it has been demonstrated that groups tended to choose one of the two and always follow that one. The choice was made in accord to the way they initially coordinated themselves with success (the reach of the target) and this behaviour successively used to influence the ways the members of the team acted. This type of behaviour suggests the existence of a phenomenon that persists during all the game: the path-dependence effect. The term path-dependence enlightens how all the sets of decisions undertaken by one or more individuals is actually limited by the decisions they have been made in the past; consequently, they tend to be very rigid and individuals anchor their strategies in one way or another. This is aggravated by the fact that any kind of communication or exchange of ideas was interdicted.

It is possible to distinguish the sample in the sample two groups: the routinized ones (the ones who were choosing just a strategy and followed it until the end), the flexible pairs (those who used both). Although one might conclude, intuitively to what we have said until now, that the flexible couples were the most efficient, it was not true. In the end, the routinized couples resulted to be the most efficient during all the game. Indeed, not only they could rely on a higher degree of speed, but they could trust a pathway that was already established and, in such conditions of uncertainty in which they could not talk, a simpler strategy was the best option.

So, Egidi and Bonini were able to verify that routinized behaviours can be really effective for reaching the result, since they can simplify significantly the task to achieve. Moreover, they can also help to reduce the amount of ambiguous or useless information in a team. Yet, rigidity in the game should not be underestimated. Even though the use of routines gives rise to certain advantages, there might be the case in which changes in the strategies should be undertaken. For example, in some cases, during the game there might be modifications in a player's mind or external framework that may vary the condition of the game. These situations, if addressed with the same routinized strategy, could lead the team to a dead-end situation or, as we called before, to a condition of suboptimality.

4.3 Team Coordination through the TTT game

Coordination is for sure the most distinctive feature in team decision-making. Although its role is undeniably fundamental for assuring a good level of efficiency, this phenomenon has not been adequately studied. There might be several definitions of coordination. Malone defines it as "*management of dependencies among independent activities*". In agent theory, coordination has been defined as "*the activity that involves the selection ordering and communication of the results of agent activities as that an agent works effectively in a group setting*". Many studies in the last years have demonstrated that greater is the level of familiarity among the members of the team, higher will be the degree of coordination is present. Familiarity is strictly correlated with the level of homogeneity or cohesion among the members of the team or the group and it is positively correlated with the effectiveness of the performance. Nevertheless, we should not think that this is the factor that contributes to the reach of success: Katz has pointed out that another important factor is the longevity of the team, while Leedom and Simon also demonstrated how those teams who received a basic standardized training are more efficient than those which members are just familiar among each other. However, the better performance achieved by those groups that are more familiar with each other, and therefore they are highly coordinated, can be also explain by the fact that the members of the teams have been provided of accurate expectations concerning the needs, priorities and action sequences of his colleagues. As a proof, Cream has shown that the formulation of accurate expectations concerning the future expectations for the results that a team must reach is a good factor of success.

It is possible to see that coordination is distinguishable in two different categories: cooperative and non-cooperative. In the former case, each member of the team considers the needs and functions of the others, but they also create an environment in which they can all work in harmony. On the other way around, the term non-cooperative coordination indicates that each member of the team thinks solely to control the conditions for their own actions and to perform these actions correctly.

Also in this case, Egidi and Bonini used a further develop of the Target The Two game in which they concentrated on verifying the presence of some form of cooperation among the members of the team. To do so, they studied whether they divided a sample of students in two groups that were trained to follow a specific strategy to complete the task: respectively, 422 and 442. Among all the hands that the groups had to play (42), 6 of them were similar

in terms of modalities applied. These two distinctions were imposed to see whether there might be different types of coordination arising.

In conclusion, after having analysed the strategies of game used by each team, the researches agreed that they may coordinate themselves both by following a cooperative and a non-cooperative strategy in accord to the best fit needed to reach the goal. However, what is extraordinary is the nature of non-cooperative coordination. Indeed, the test showed that non-cooperative coordination is basically dependable from the context in which it is arising and from informal characteristics of the situation addressed by the team.

Conclusions

This elaborate had as its main object trying to understand whether the Mirror Neuron System has a role in the constitution, transmission and gathering of routines. Our second aim was trying to verify Cohen and Bacdayan's statement that routines are stored within Procedural Memory. In order to do so, we provided a definition of routines that were described as a series of repetitive, recognizable patterns of interdependent actions, carried out by multiple actors. Successively, we designed an experimental study that was reprised by the Cohen's original Target The Two game thanks to which we have been able to verify our hypothesises. For this game, we have been taken in consideration two different factors, respectively Action and Routine that were studied through the use of factorial ANOVA. Regarding the sample used, we took 82 participants: 46 males and 36 females with an average age of 23.56 all graduate or upper-level undergraduate students.

Successively, we have turned our attention on the analysis of the data gathered from observing the members of the sample play. From this study, we have been able to recognise that the Mirror Neuron System seems to have a role in the constitution and spread of routines, since it has been possible to observe the presence of the four main characteristics of routines: reliability, speed, repeated action sequences, occasional suboptimality. Moreover, we verified that procedural memory is the only type of long-term memory who has a role in the storage of routines. Its counterpart, the declarative memory occurs in a limited or non-existing way.

In addition, by reprising Egidi and Bonini's own version of the TTT game, we also analysed two other important aspects of routines: flexibility, or more exactly rigidity, and coordination. Regarding the first matter, it has been possible to see that routines show a behaviour of path-dependency. That means they tend to be very rigid and anchor individuals' strategies to specific already-proved tracks. This aspect, of course, occurs to be both an advantage and a disadvantage in accord to the environment and to the situation individuals have to face. Regarding coordination, it is present in two different forms; respectively, cooperative and non-cooperative. In the first case, each member of the team regulates his/her action accordingly to the others' functions and necessities. In the other case, each member thinks just as a single individual without considering the other subjects on the team.

Our starting point for all this study was the analysis of the Mirror Neuron System. Although relatively recent, the studies on MNs have spread significantly overtime. At first by starting

from the studies on monkeys during the ’80, the discovers about this matter are still object of discussion among scientists. This is due to the fact that, still now, it is difficult to identify what Mirror Neurons allow to perform and their limits are. Certainly, it is undeniable that our focus during the thesis, imitation, is just a side of this aspect and not even the central one. According to Rizzolatti and the majority of neurophysiologists, the main objective of the MNS is actually transforming visual information into knowledge.

As a matter of fact, there is still no real evidence of mirror neurons in human. Their main source of discovery is due to Fadinga that, in 1995, performed different Transcranial Magnetic Stimulation (TMS) studies through which it has been possible to confirm that the MNS is present and formed by two regions: (i) the rostral part of the inferior parietal lobule and (ii) the lower part of the precentral gyrus plus the posterior part of the Inferior Frontal Gyrus (IFG). Furthermore, human’s version of the MNS seems to have more properties that the monkey’s one. Indeed, apart from action understanding, imitation and transforming visual information into knowledge, the Mirror Neuron System in humans appears to detect also performing no-sense arm gestures and the gestures forming the action without the action per se.

However, there is still a long way to go. We have just started to slightly understand the beauty and complexity of this apparatus and still the possibilities appear to be endless. Indeed, as Stuart Seaton said, “*the human brain is a most unusual instrument of elegant and as yet unknown capacity”.*

Acknowledgements

For the creation of this elaborate, I have to thanks my Supervisor Prof. Alessandro Marino as well as my Co-Supervisor Prof. Maria Isabella Leone. Above all, however, I have to thanks Doct. Cinzia Calluso, Porstdoctoral Researcher fellow, for her great support and help during this journey and my sister Alessandra Catanzaro for her help in the understanding, at least in part, the mechanisms of MNS. Finally, I would like to thank my friend and colleague Viola Mazza Micara for all the information and material she shared with me.

References

Caldas, T. Patricia; Candido, A. Gesinaldo (2013). Intern-Organizational Knowledge Conversation and Innovative Capacity in Cooperative Networks. Journal of Technology and Management & Innovation;

Nonaka; Takeuchi (1997). Spiral of organizational knowledge creation;

Levitt, Barbara; March, James G. (1988). "Organizational Learning". Annual Review of Sociology;

Coleman, J.S. (1990). Foundations of Social Theory. Cambridge (Mass.); London: the Belknap Press of Harvard University Press;

Abell, Peter; Felin, Teppo; Foss, Nicolai (2008). "Building micro-foundations for the routines, capabilities, and performance links". Managerial and Decision Economics;

Andrews, B. R; (1903). "Habit". Am J. Psychol;

Redish, A.D.; Jensen, S.; Johnson, A. (2008). Addition as vulnerabilities in the decision process. BehavBrain Sci;

Levitt, B.; March, J. (1988). "Organizational Learning". Annual Review of Sociology;

Nelson, Richard R.; Winter, Sidney G. (1982). "An Evolutionary Theory of Economic Change". Belknap Press/ Harvard University Press;

Gersick, C. J. G.; Hackman J. R. (1990). "Habitual Routines in Task-Performing Groups". Organizational Behavior and Human Decision Processes;

Becker, Markus C.; Lazaric, Nathalie; Nelson, Richard R.; Winter, Sidney G. (2005). "Applying organizational routines in understanding organizational change". Industrial and Corporate Change, Volume 14, Numer 5, pp. 775-791;

Meltzoff, Andrew N.; Decety, Jean. (2003). "What imitation tells us about social cognition: a rapprochement between developmental psychology and cognitive neuroscience". The Royal Society;

Bonini, Nicolao; Egidi, Massimo. (1999). "Cognitive traps in individual and organizational behavior: some empirical evidence". Revue d'économie industrielle;

Cohen, Michael D. (2012). "Perceiving and Remebering Routine Action: Fundamental Micro-Level Origins". Journal of Management Studies;

Cohen, Michael D.; Bacdayan Paul. (1994). "Organizational Routines Are Stored As Procedural Memory: Evidence from a Laboratory Study". Organization Science, Vol. 5, No. 4, pp. 554-568. INFORMS;

Boella, Guido; Van Der Torre, Leendert. (2006). "Coordination and Organization. Definition, Examples and Future Research Directions". ELSEVIER.

Castellani, Marco; Novarese, Marco. (2015). "Le routine nelle organizzazioni". Sistemi Intelligenti.

Zarr, Noah; Ferguson, Ryan; Glenberg Arthur M. (2013). "Language comprehension warps the mirror neuron system". Frontiers in HUMAN NEUROSCIENCE;

Lazaric, Nathalie. (2000). "The role of routines, rules and habits in collective learning: Some epistemological and ontological considerations". European Journal of Economic and Social Systems 14 N° 2 157-171;

Becker, Markus C. (2000). "The concept of routines twenty years after Nelson and Winter (1982). A review of the literature". Department of Marketing, University of Southern Denmark;

Ridinger, Garret; McBride, Michael. (2016). “Theory of Mind Ability and Cooperation in the Prisoners Dilemma”. Experimental Social Science Laboratory at UC Irvine;

Feldman, Martha S.; Pentland, Brian T. (2003). “Reconceptualizing Organizational Routines as a Source of Flexibility and Change”. Administrative Science Quarterly, 48.

Rizzolatti, Giacomo; Craighero, Laila. (2004). “The Mirror-Neuron System”. First Published as a Review, University of Colorado;

Rizzolatti, Giacomo; Fogassi, Leonardo; Gallese, Vittorio. (2001). “Neurophysiological mechanisms underlying the understanding and imitation of action”. Natural Reviews, Neuroscience. Macmillan Magazines Lltd;

Houchens, Gary W.; Keedy, John L. (2009). “Theories of Practice: Understanding the Practice of Educational Leadership”. Journal of Thought.

Grant, Robert M. (2016). “Contemporary Strategy Analysis”. 9th edition. Wiley;

Feenstra, Robert C.; Taylor, Alan M. (2014). “International economics”. 3rd edition. Worth, Macmillan;

Kotler, Philip; Keller, Kevin, L.; Ancarani, Fabio, Costabile, Michele. (2012). “Marketing Management”. 14th edition. Pearson;

Kandel, Eric R.; Schwartz, James H.; Jessell, Thomas M.; Siegelbaum, Steven A.; Hudspeth, A. J. (2013). “Principles of Neural Science”. 5th edition. McGraw Hill Education;

[i] With the term evolutionary economics, it is defined the theory promoted by Nelson and Winter in their work "An Evolutionary Theory of Economic Change"

[ii] From now on, the term Mirror Neuron System could be abbreviated through the formula MNS, as well as Mirror Neurons (MNs);

[iii] To be clearer, we should better indicate the term rigidity instead of flexibility;

[iv] This phrase is obviously referred to the TTT game that will be studied in the successive chapters;

[v] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3532569/

[vi] Medicine is a never-ending changing science. As new researches and clinical experiences may arise, there might be some inconsistencies with the current researches' work;

[vii] to know more about Rizzolatti et. all, please check:

" https://www.youtube.com/watch?v=87_6WJhWTms";

"https://www.youtube.com/watch?v=5Th0aOoX4EM;"

[viii] Present in the frontal cortex;

[ix] an organ that becomes dynamic in response to nerve impulses;

[x] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2900004/;

[xi] although it has not been enlighted here, there are important though secondary functions of MNS, such as: social communication and empathy, theory of mind (people's capacity to understand that everyone has a different brain), social cognition, speech;

xii Electroencephalogram;

[xiii] It is non-invasive technique that uses magnetic fields to stimulate nerve cells in the brain to stimulate the brain. It involves the transmission of repetitive magnetic pulses, so it is repetitive TMS or rTMS;

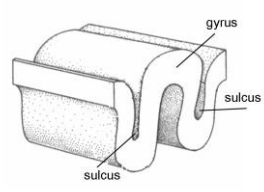
[xiv] With this term potential, we refer to the electric firing of neurons: this is the method through which signals are relayed in the CNS (Central Nervous System) and distally to other areas of the body;

[xv] This area is represented in the first image below;

[xvi] This area is represented in the other page;

[xvii] Also in humans the STS has an important role, similar to the one saw in apes. However, also in this case there is no a real presence of motor neurons; so, it is not considered;

[xviii] The term gyrus (plural gyri) indicates a ridge in the cerebral cortex. The picture is shown below:



[xix] It is a technique used to measure brain activity by changing the changes in blood pressure;

[xx] Another important definition is linked with the branch of sociology according to which the mechanisms of imitation is a sort of social learning without the need of generic inheritance;

[xxi] Although the main interest was on humans, the same phenomenon of imitations has been seen also in new-born rhesus macaque:

[xxii] positron-emission tomography;

[xxiii]Although the general methods used are not innovative, it has been interesting used different instruments like Solomon Coder to assess the results by analysing the records made. This type of methodology allowed us to reduce as much as possible the level of contamination from subjects' verbalising in real time;

[xxiv] Company of automobiles in Fremont jointly owned by GM and Toyota, opened in 1984 and closed in 2010;

Summary

Contents

Extreme Synthesis

- **Main objectives of the thesis:**
  - studying organizational routines and trying to explain their origins by focusing on the "Mirror Neuron System";
  - verifying if routines are stored in the procedural memory;
- **Main points analysed:**
  - the first chapter concentrates on organizational routines according to the first definition proposed by Nelson and Winter and their roles in following theories;
  - the second chapter analyses the "Mirror Neuron System" and mirror neurons;
  - the third chapter concentrates on our experiment inspired by the "Target The Two (TTT) Game" developed by Cohen and Bacdayan. In particular, the two following hypothesises that have been reviewing are:
    1. if MNS have a role in forming organizational routines;
    2. if they are stowed in the procedural memory;
  - the last chapter proposes the analysis of flexibility and coordination by verifying their presence in a team through the TTT game;
- **Main conclusions:**
  - the two hypothesises are verified;
  - the acknowledge that in teams under routines:
    - there is a condition of rigidity;
    - coordination is present in both cooperative and non-cooperative form;
  - **further elements to develop**:
    - additional studies inspired by the TTT experiment could help in overcoming the inefficiencies of routines;
    - the MNS is still a new field, there is room for further discovers about its cognitive functions;
- **Main references:**
  - Rizzolatti, Giacomo; Craighero, Laila. (2004). "The Mirror-Neuron System". First Published as a Review, University of Colorado;
  - Rizzolatti, Giacomo; Fogassi, Leonardo; Gallese, Vittorio. (2001). "Neurophysiological mechanisms underlying the understanding and imitation of action". Natural Reviews, Neuroscience. Macmillan Magazines Lltd;
  - Cohen, Michael D. (2012). "Perceiving and Remebering Routine Action: Fundamental Micro-Level Origins". Journal of Management Studies;

Introduction

The concept of organizational routines was at first developed by Nelson and Winter in 1982 and can be described as "*repetitive, recognizable patterns of interdependent actions, carried out by multiple actors".* From that moment, the concept of routines enlarged greatly as being taken as basis in different contests and theories and still now, their nature is subject of discussion among scholars.

Although the role of routines within the borders of the company is without any doubt important, it is not easy to clarify their exact origin: how they are created and through which mechanisms they spread. In 1994, Cohen and Bacdayan developed an experiment called *Target The Two* (TTT), to prove that the creation of organizational routines can be influenced by the so-called *Mirror Neurons* and that routines are store in the *Procedural Memory*. Rizzolatti argued the existence of a neural network, called *Mirror Neuron System*[i], which has an important role in the coordination with other individuals via imitation of action. Regarding procedural memory, it consists in a type of long-term implicit memory that aids in the memorization of motor and cognitive skills and it is usually differentiated by the declarative memory. They can be thought as two machineries working for different aims: procedural memory to store the "knowing how", while declarative memory as the "knowing what" mechanism of storage. In this thesis, the aim is to investigate the definition of organizational routines and their acquisition through the mechanism of Mirror Neuron System. To do so, we are going to study: (i) at first the characteristics of routines, as well as their history and the elements that can in some way influence them; (ii) successively, the analysis will concentrate on discovering in detail what Mirror Neurons are; (iii) to verify whether MNS has role in the constitution of routines and if they are stored within the procedural memory, we have been developing a personalized version of Cohen and Bacdayan's Target The Two Game; (iv) finally, we are going to see other successive development of the TTT game proposed by Egidi and Bonini to confirm the presence or absence of two important features of two important characteristics of routines: flexibility[ii] and coordination.

Organizational Routines

According to almost overall scholars, organizational routine can be easily described as a series of coordinated, repeated and consequent actions that become of outstanding importance for the rightful functioning of an organization. Without routines, organizations would suffer a strong lost in efficiency as structure of collective action.

The first *real* "draft" of the concept was given by Nelson and Winter in 1982 and, since then, the concept developed greatly. The first idea expressed by the two authors was exposed in "An Evolutionary Theory of Economic Change". According to Nelson and Winter, organizational knowledge is saved within routines as "the memory of the company", since they represent, implicitly

or explicitly, all those series of actions on which the company is built upon. There may be identified two different types of routines, called respectively Operative Routines and Strategic Routines. The former represents all static rules that direct the behaviour of all individuals in the organization in the short run. While the latter is formed by series of dynamic rules that drive the growth of the company and favour innovation. The real power of these systems consists in their ability of reorganize all the assets in the best strategic "fit" for that specific company.

So, as it is possible to understand, routines are quite complicated, and their analysis can be very long. However, it is obvious how they may represent a form of strategic advantage for a firm. Since routines can be understood as social replicators, mechanisms that can pass (or replicate) certain behaviours and knowledge, their importance has been overwhelmingly praised in the area of Resource-based view of firms. According to Abell and Felin, routines can be seen as a micro-foundation for the future develop of organizational capabilities and dynamic capabilities. More specifically, they are seen as important tools to understand important knowledge-based phenomena as heterogeneity, competitive advantage, diversification patterns and innovation. Routines may be also associated with a high-productivity equilibrium since they lead to a better coordination of the resources and their use. However, it has been demonstrated that the pattern followed by the resources to build the competitive advantage is never straight and consequential, but it can entail individual skills, motivations and actions. Consequently, it is not easy understand how some results are practically reached.

It might be possible to misunderstand the term "routine" with the so-called *"standard operating procedures*". The main difference is that while routines are designated patterns of organizational actions, standard operating procedures are rules more explicitly formulated and have normative standing. Thus, the working routines of an organization may or may not be equivalent to its official standard operating procedures. This gap becomes clearer by thinking that the standardized procedures might not be able to manage or help to handle real – time situations and the use or less "technical" procedures becomes necessary. Another element that must be accounted is the difference between *"habit*" and routine. Although habits are conceptually different from routines, they share with them some key elements. Andrews defines habits as "*a fixed way of thinking, willing, or feeling acquire through previous repetition of a mental experience*". So, while the term "routine" is referred exclusively for describing organizational actions, the term "skill" or "habit" at the individual level. Habits, since are personal, are often carried out unnoticed and are not automatized by the company.

In their outstanding work *An Evolutionary Theory of Economic Change* (1982), Nelson and Winter link the concept of routines with the concept of gene. Their basic idea is very simple: they not only

are micro-foundations for the structure of the company, but they can also help to develop since they can evolve. Moreover, they identify four basic characteristics, which are:

- Reliability. Routinization, with time, can increase the ability of the members of the organization to produce acceptable results and consequently increase the trustworthiness of certain procedures;
- Speed. Along with reliability, routinized actions are implemented faster than procedures that are generated freely by the members of the organization;
- Repeated Action Sequences. A main element of routines is that the actions that form them are basically the same over time;
- Occasion Suboptimality. One of the main disadvantage of routines is the observed tendency to "fire on" automatically in circumstances where their application is actually not needed, but instead the execution some action would have been more appropriate.

Therefore, routines appear to be a major resource of competence. When the decision-making process become a heavy burden for the company, they can become a useful instrument for reducing recurring costs. When experienced processes are transferred to specific situations, they not only provide a major determinant of the short-run responses to external stimuli, but they do so efficiently by decreasing the effort spent on decision-making and implementation. Without routines, organizations would not be as efficient as they actually are.

As previous said, organizational routines are specific. Consequently, their implementation in other companies can be bad. However, this same effect can happen also within the borders of the same company. For example, control room operators' vigilance may erode when they become so accustomed to answering each safety check "okay" that they do not see trouble when it actually is present.

Since "organizational routines" are patterned consequences of learned behaviour involving multiple actors that communicate and interact, they involve not only an institutional part, but also heterogeneous objectives given by the personal capabilities or values/attitudes of the employees of the organization. Thus, as previously said, the working routines of an organization may or may not be equivalent to its official standard operating procedures. The understanding of routines is hampered by three different characteristics:

- Routines are multi-actor and thus, their observation can be very hard to do;

- Organizational routines provide productive conditions for the evolution of behaviour patterns by experimental learning rather than explicit decision making. Moreover, their emerging is "contaminated" with extraneous, historical elements that were previously contained by the cultural luggage of the company. Routines may also preserve objects of old technologies that are considered to be obsolete;
- The underlying knowledge of the parts of routines held by individual actors is often inarticulate. Although managers and the most experienced individuals seem to understand "routines", this is not true. Indeed, they just cannot put in words their nature and their implantation;

Cohen, starting from the concepts of micro-foundations and habits, recognizes that organizational routines seem to rely substantially on the so-called *Procedural memory or Implicit memory*. Procedural memory is a type of memory that is in charge of storing individual skilled actions for both motor and cognitive skills. Generally speaking, it is distinguished by the so-called declarative memory or explicit memory which is the other type of long-term storage memory that regards facts, propositions or events. The main difference among the two that can help to explain how they work is found in the analysis of patients affected of amnesia.

According to Cohen, a second psychological capacity that gives a strong impact on the creation of routines is the so-called action-specialized perceptual capability that has been labelled in recent years as the *dorsal perceptual system*. The dorsal perceptual system is usually compared to the ventral system. The ventral pathway plays an important role in the definition of speech. On the other way around, the dorsal pathway is clearly associated with the definition and preparation of the action. On the contrary of the studies on procedural memory, the ones of the dorsal perceptual system are actually quite new, especially their application in explaining routines. However, the results reached since now are quite promising. Indeed, there has been found a strong alignment of known properties on routines with findings on the dorsal perceptual system in individuals and small groups. Numerous psychologists have argued that the dorsal perceptual system is responsible for two specific phenomena; the affordance and the anticipation. The former was argued by J.J. Gibson (1979) to be responsible for perceiving a certain product as "sit-able" or "climb-able" relative to how we relate with certain object such as chairs or stairs.

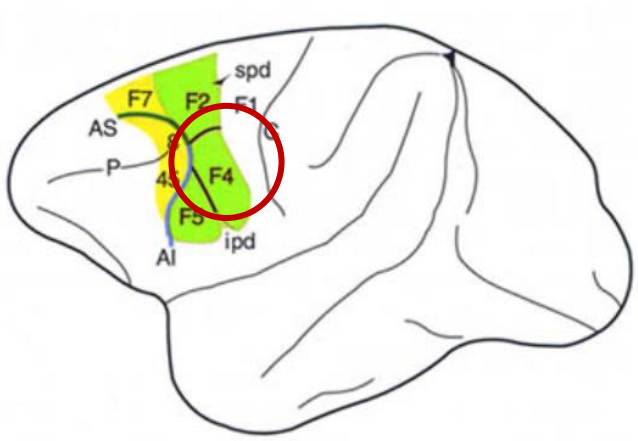
The latter can be considered as a hallmark of action sequences in individual skills and organizational routines. The same phenomenon can be observed in teams or in working situations. Anticipation permits routines to be enacted very easily and quicker as activities that prepare for a consequent step

can be overlapped with a current step, rather than waiting for the starting point of the following step to be fully realized by current action.

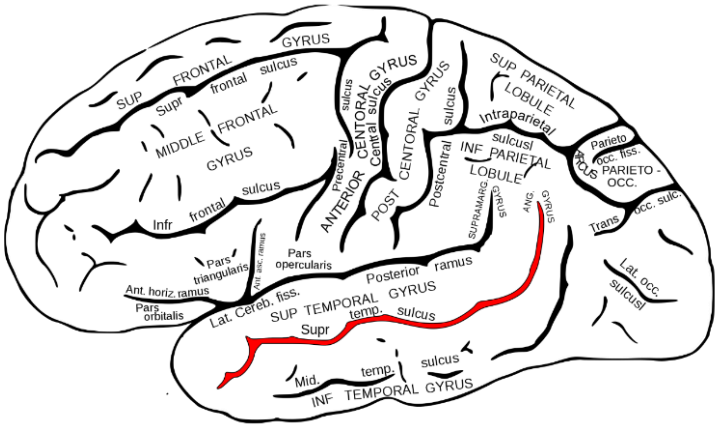
Routines seen by Human Mirror System's output

As we previously pointed out, the way through routinized behaviours emerge and spread among multiple actors is still an open question. An interesting perspective about this matter is offered by a neuro-cognitive mechanism; more specifically, by the one known as *Mirror Neuron System* (MNS)[iii]. The MNS is formed primarily by the so-called *Mirror Neurons*. These are a particular class of neurones originally discovered in are F5 of monkeys' premotor cortex, that discharge both when the monkey does a particular action and when it observes another doing a specific action.

The basic characteristic of the mirror neurons is that they are activated specifically through an interaction between a biological effector[iv], such as hand or mouth, and an object. The solely visualization of the object alone or of an individual making non-objective directed gestures are all unproductive. Mirror neurons work through a large scale of generalization; they can be enacted by different kind of visual stimuli which that can present all the same action.



A region in which neurons with these characteristics have been found is the Superior Temporal Sulcus (STS; the highlighted in red). The neurons located in this area respond effectively to movements such as walking, turning ahead, bending the torso. Just a restricted group of mirror neurons in this area discharge also during the observation of goal-directed hand movements. By the comparing the functional properties of STS and F5 neurons, there are two different elements that must be pointed out. First of all, STS seems to be recognising a much larger number of movements than F5. This can be due to the fact that the STS area can reach, albeit indirectly, the whole ventral premotor region and not only F5. Secondly, STS neurons do not appear to be endowed with motor properties, that means they do not discharge when a movement is performed.



Another important area where the neurons have been responding to the observations done by scientists is the so-called 7b or PF of Von Economo. This area constitutes the rostral part of the inferior parietal lobule and it is in charge of receiving the inputs from STS and of sending an important result to the ventral premotor cortex including area F5. The neurons in this area are characterized by a high functionally heterogeneity. About the 90% of them responds to sensory stimuli, but about 50% of them also have motor properties that can be seen when a monkey performs a specific action or movement. Regarding human brain, it has been discovered that the Mirror Neuron System is formed primarily by two regions: (i) the rostral part of the inferior parietal lobule and the lower part of the precentral gyrus plus the posterior part of the Inferior Frontal Gyrus (IFG)[v].

The role of Mirror Neuron System is quite various. Imitation regards motor behaviours that are determined by the observation of actions enacted by conspecifics. Generally, imitated actions can be characterized by a full comprehension of the original action and being an approximated replica involving actions never performed by the implementor. Although the majority of the most "classical" ethologists recognise only this type of imitation process, it is true that nowadays the most basic phenomenon characterizing imitation is that which has been defined "response facilitation" (RF). The response facilitation is the automatic propensity to reproduce an observed movement. It is a phenomenon that can and cannot concern the understanding the action. In the first case, it consists in an "ancient" and unconscious activity that is inner different species. One of the most classical examples regards the ability of infants to imitate buccal and manual gestures learned by their parents. On the other way around, if the action of imitating is made "consciously", it can be enacted by different "triggers". The first one is for a sort of "symbolism" or "quasi-symbolism", such as social gestures (shacking hands, arm movements to invite someone in, etc.), while the other group of reasons is related to goal-related behaviours: motor acts and motor actions. This type of distinction actually very logic, but it corresponds to the way in which the motor system is organized. With motor acts,

scholars intend all those movements that are directed towards an object and that allows an effective interaction of the individual in external factors. Examples of motor acts are grasping an object, holding it. While, motor actions regard all those movements, or sequences of movements, that lead to the accomplishment and produce a reward. For example, a typical motor actions may be composed by all the sequences of motor acts performed to allow feeding.

The second is that mirror neurons are fundamental for action understanding. Apart for imitation and action understanding, the *primary function of mirror neurons is transforming visual information into knowledge.*

Finally, it has been shown that also intransitive meaningless movements, such as performing no-sense arm gestures, that do not cause any response in monkeys are detected. Moreover, the excitability registered in the temporal areas of cortex, especially during action-observation, suggests that human mirror-neuron systems code also for movements forming an action and not only for action as monkey mirror-neuron system do.

The Experiment

We conducted to prove that MNS has a basic role in the constitution of routines. To do so, we have been taking as principal root for the construction of our study the experiment called Target The Two (TTT) previously conducted by Cohen and Bacdayan in 1994. The study is a combination on qualitative and quantitative research and it was based on the employ of a card game. This result to be a good environment for our research, since it provides a good field for the experiment. To start, we designed the experiment by taking into analysis two factors: Action and Routine. Successively, we developed two different levels for each factor. More precisely, in the former case, we have chosen to analyse the Observation, so to undergo the test in a situation in which the members of the sample could see each other moves, and the Hidden level in which they could not see the others' moves. For the latter, we have tried to take in consideration an approach that enhances routinization, by giving to the test the same task to complete (Formation). In the other case, the aim was trying to obstruct the formation of the routine by always changing the task to be completed (Obstruction).

Experimental design:

- 2 x 2 between-subjects' design:
    - **Action:** observation vs. hidden;
    - **Routine:** formation vs. obstruction

Since two factors are considered, each of them with two levels, there are in total 4 possible conditions by considering their combination These are:

- Formation – Observation: this is the easiest condition. The sample is subjected to always the same target and they can see each other moves;
- Formation – Hidden: in this case, the target remains the same for all the game, but the two of them cannot see the other's moves;
- Obstruction – Observation: the routines is obstructed, the target changes at every hand, but the players can see each other;
- Obstruction – Hidden: this is the hardest possible state, the goal to reach changes every time and a panel is placed between the two in order to cover the other's moves;

The experimental task is between subject: it means that each group of subjects is submitted to just one condition. When the experimental tasks are between two subjects, it is possible to use the ANOVA Factorial Analysis. The ANOVA uses the *F* test, which means it allows scholars and researchers to compare different groups even though group means differ. The *F* test is the ratio of two independent variance estimates of the same population variance. We decided to consider an alpha test of 0.05.

It is possible to have three kinds of information:

- The effect of the Action (whether it is under the condition Hidden or Observation);
- The effect of Routine (by studying both the hypothesis of Formation and Obstruction);
- The interaction between Routine and Action;

We studied four different indexes to evaluate: the first type of evaluation was made by analysing the Number of Moves: so, the number of moves used to complete each hand. From this data, it appears to be clear that both Routine and the Interaction between Action and Routine are not significant. While, on the other hand, the only effect that is significant is the one of the Action. What does it mean? It means that independently by the application of the Obstruction or the Formation condition, the performances have almost an equivalent number of moves made.

For the second case we decided to evaluate the game and the experiment by a broader point of view. Indeed, the second evaluation was made by analysing the total number of moves needed to conclude the game. Also, from these parameters, it is possible to see that also in this case the Routine and the Interaction between Action and Routine are not significant. Still, Action is significant with a $p < 0.05$. So, also in this case both in the case of Formation and Obstruction, there is, on average, the same number of moves made.

For the third evaluation, we took in consideration the Responses Times, which means the time needed for each to play their move. In this case, there are two effects that result to be significant: Action, as

always, and Routine (marginally significative since p= 0.05). That means that, in general, those under condition of Formation are faster movers than those under Obstruction condition. However, although this effect is particularly visible under the Hidden conditions, it is worth also for the Observation.
Finally, the last index to evaluate the experiment was the Total Time. We have to specify this is not the all 40 minutes that are set as. Indeed, this is the time calculated by estimating the reaction time that was need to each player to do his/her move. So, for summing up, it is actually just the time "game timing".
From all these data, it is possible to confirm the initial hypothesises: those who are able to observe themselves are also able to develop in a faster and in a more efficient way a mechanism of routinization. the real difference was between the condition of Observation and Hidden. Obviously, we are not saying that those under Hidden condition were not able to develop a routine, but the process leading to its formation was delayed so much that sometimes it resulted to be useless for the reach of the game's goal.
Successively, there have been proves of the existence of the so-called "Speed-Accuracy trade-off" experienced by our participants when they were performing the game. It was possible to see that all the gamers under the Observation condition tended to be faster than those under Hidden condition. However, as a drawback, they were also less accurate than the others.
that arise when routines come in play. These are:

- reliability (the increased ability of the organization to produce a good result);
- speed (routines make procedures generally faster than average);
- repeated action sequences (usually routines are composed by the same sequences of actions or habits);
- occasional suboptimality (although they lead to a general increase of efficiency, there are some case of suboptimality that may happen).

As a result, we have demonstrated that the only type of memory that plays an important role during the game is the procedural one; while, the declarative memory has a marginal or non-existing role in the matter.

Routinized Group Behaviour: a broader approach to the TTT experiment

In the last section, the study concentrated on a successive work that took inspiration from Cohen's work regarding the formation of organizational routines espoused by Nicolao Bonini and Massimo Egidi in their work *"Cognitive traps in individuals and organizational behavior: some empirical evidence"* (1999) in which they used the Target The Two experiment to study two phenomena: Flexibility and Cooperation. Flexibility is an important competitive advantage for a team since

regards its ability to adapt more rapidly to changes in the environment and in the conditions in which the team operates. Egidi and Bonini analysed the problem of rigidity/flexibility that may incur in teams by using their own version of the experiment Target The Two card game. The two authors concentrated on analysing two different strategies detected if the players were in a condition in which, in the beginning, in the Target area there the 3 ♣ or 4 ♣. These are:

- The 4 ♣ 4 ♥ 2 ♥ strategy: in this strategy, the Number Keeper is the leader of the game because he first acts by placing the 4 ♥ and by letting the Colour Keeper finish the game by placing the 2 ♥ in the Target Area;
- The 4 ♣ 2 ♣ 2 ♥ strategy: here the Colour Keeper is in charge of managing the strategy because he first puts the 2 ♣. Consequently, the Number Keeper can conclude by putting 2 ♥ in the Target;

The two strategies resulted to be both very efficient and led to the same result (placing the 2 ♥ in the Target), consequently they could be used with the same degree of discretion. However, it has been demonstrated that groups tended to choose one of the two and always follow that one. The choice was made in accord to the way they initially coordinated themselves with success (the reach of the target) and this behaviour successively used to influence the ways the members of the team acted. This type of behaviour suggests the existence of a phenomenon that persists during all the game: the path-dependence effect. The term path-dependence enlightens how all the sets of decisions undertaken by one or more individuals is limited by the decisions they have been made in the past; consequently, they tend to be very rigid and individuals anchor their strategies in one way or another. Although one might conclude, intuitively to what we have said until now, that the flexible couples were the most efficient, it was not true. In the end, it has been possible to demonstrate that the routinized couples were the most efficient during all the game. Indeed, not only they could rely on a higher degree of speed, but they could trust a pathway that was already established and, in such conditions of uncertainty in which they could not talk, a simpler strategy was the best option. Even though the use of routines gives rise to certain advantage, there might be the case in which changes in the strategies should be undertaken. For example, in some cases, during the game there might be modifications in a player's mind or external framework that may vary the condition of the game. These situations, if addressed with the same routinized strategy, could lead the team to a dead-end situation or, as we called before, to a condition of suboptimality.

Coordination is for sure the most distinctive feature in team decision-making. Although its role is undeniably fundamental for a good level of efficiency, this phenomenon has not been adequately studied. There might be several definitions of coordination. Malone defines it as "*management of*

dependencies among independent activities". It is possible to see that coordination is distinguishable in two different categories: cooperative and non-cooperative. In the former case, each member of the team considers the needs and functions of the others, but they also create an environment in which they can all work in harmony. On the other way around, the term non-cooperative coordination indicates that each member of the team thinks solely to control the conditions for their own actions and to perform these actions correctly. As a matter of fact, after having analysed the strategies of game used by each team, the researches agreed that they may coordinate themselves both by following a cooperative and a non-cooperative strategy in accord to the best fit needed to reach the goal. However, what is extraordinary is the nature of non-cooperative coordination. Indeed, the test showed that non-cooperative coordination is basically dependable from the context in which it is arising and from informal characteristics of the situation addressed by the team.

Conclusions

This elaborate had as its main object trying to understand whether the Mirror Neuron System has a role in the constitution, transmission and gathering of routines. Moreover, our second aim was trying to verify Cohen and Bacdayan's statement that routines are stored within Procedural Memory. In order to do so, we provided a definition of routines that were described as a series of repetitive, recognizable patterns of interdependent actions, carried out by multiple actors. Successively, we have been able to certificate the two hypothesises through an experimental study that was reprised by the Cohen's original Target The Two game. For this game, we have been taken in consideration two different factors, respectively Action and Routine that were studied through the use of factorial ANOVA. Regarding the sample used, we took 82 participants: 46 males and 36 females with an average age of 23.56 all graduate or upper-level undergraduate students.

Successively, we have turned our attention on the analysis of the data gathered from observing the members of the sample play. From this study, we have been able to recognise that the Mirror Neuron System seems to have a role in the constitution and spread of routines, since it has been possible to observe the presence of the four main characteristics of routines: reliability, speed, repeated action sequences, occasional suboptimality. Moreover, we verified that procedural memory is the only type of long-term memory who has a role in the storage of routines. Its counterpart, the declarative memory occurs in a limited or non-existing way.

In addition, by reprising Egidi and Bonini's own version of the TTT game, we also analysed two other important aspects of routines: flexibility, or more exactly rigidity, and coordination. Regarding

the first matter, it has been possible to see that routines show a behaviour of path-dependency. That means they tend to be very rigid and anchor individuals' strategies to specific already-proved tracks. This aspect, of course, occurs to be both an advantage and a disadvantage in accord to the environment and to the situation individuals have to face. Regarding coordination, it is present in two different forms; respectively, cooperative and non-cooperative. In the first case, each member of the team regulates his/her action accordingly to the others' functions and necessities. In the other case, each member thinks just as a single individual without considering the other subjects on the team.

Main References

Rizzolatti, Giacomo; Craighero, Laila. (2004). "The Mirror-Neuron System". First Published as a Review, University of Colorado;

Rizzolatti, Giacomo; Fogassi, Leonardo; Gallese, Vittorio. (2001). "Neurophysiological mechanisms underlying the understanding and imitation of action". Natural Reviews, Neuroscience. Macmillan Magazines Lltd;

Cohen, Michael D. (2012). "Perceiving and Remebering Routine Action: Fundamental Micro-Level Origins". Journal of Management Studies;

Cohen, Michael D.; Bacdayan Paul. (1994). "Organizational Routines Are Stored As Procedural Memory: Evidence from a Laboratory Study". Organization Science, Vol. 5, No. 4, pp. 554-568. INFORMS;

Coleman, J.S. (1990). Foundations of Social Theory. Cambridge (Mass.); London: the Belknap Press of Harvard University Press;

Abell, Peter; Felin, Teppo; Foss, Nicolai (2008). "Building micro-foundations for the routines, capabilities, and performance links". Managerial and Decision Economics;

Andrews, B. R; (1903). "Habit". Am J. Psychol;

Redish, A.D.; Jensen, S.; Johnson, A. (2008). Addition as vulnerabilities in the decision process. BehavBrain Sci;

Levitt, B.; March, J. (1988). "Organizational Learning". Annual Review of Sociology;

Caldas, T. Patricia; Candido, A. Gesinaldo (2013). Intern-Organizational Knowledge Conversation and Innovative Capacity in Cooperative Networks. Journal of Technology and Management & Innovation;

Nonaka; Takeuchi (1997). Spiral of organizational knowledge creation;

Levitt, Barbara; March, James G. (1988). "Organizational Learning". Annual Review of Sociology;

Coleman, J.S. (1990). Foundations of Social Theory. Cambridge (Mass.); London: the Belknap Press of Harvard University Press;

Abell, Peter; Felin, Teppo; Foss, Nicolai (2008). "Building micro-foundations for the routines, capabilities, and performance links". Managerial and Decision Economics;

Andrews, B. R; (1903). "Habit". Am J. Psychol;

[i] From now on, the term Mirror Neuron System could be abbreviated through the formula MNS, as well as Mirror Neurons (MNs);

[ii] To be clearer, we should better indicate the term rigidity instead of flexibility;

[iii] Medicine is a never-ending changing science. As new researches and clinical experiences may arise, there might be some inconsistencies with the current researches' work;

[iv] an organ that becomes dynamic in response to nerve impulses;

[v] Also, in humans the STS has an important role, similar to the one saw in apes. However, also in this case there is no a real presence of motor neurons; so, it is not considered;