

When Psychology Meets Ecology: Cognitive Flexibility for Quarry Rehabilitation

J. Fenianos, C. Khater, D. Brouillet

Abstract—Ecological projects are often faced with reluctance from local communities hosting the project, especially when this project involves variation from preset ideas or classical practices. This paper aims at appreciating the contribution of environmental psychology through cognitive flexibility exercises to improve the acceptability of local communities in adopting more ecological rehabilitation scenarios. The study is based on a quarry site located in Bekaa- Lebanon. Four groups were considered with different levels of involvement, as follows: Group 1 is Training (T) – 50 hours of on-site training over 8 months, Group 2 is Awareness (A) – 2 hours of awareness raising session, Group 3 is Flexibility (F) – 2 hours of flexibility exercises and Group 4 is the Control (C). The results show that individuals in Group 3 (F) who followed flexibility sessions accept comparably the ecological rehabilitation option over the more classical one. This is also the case for the people in Group 1 (T) who followed a more time-demanding “on-site training”. Another experience was conducted on a second quarry site combining flexibility with awareness-raising. This research confirms that it is possible to reduce resistance to change thanks to a limited in-time intervention using cognitive flexibility. This methodological approach could be transferable to other environmental problems involving local communities and changes in preset perceptions.

Keywords—Acceptability, ecological restoration, environmental psychology, Lebanon, local communities, resistance to change.

I. INTRODUCTION

THIS paper is part of a project that aims at developing rehabilitation plans for two abandoned quarries (Makne and Mdoukha; Bekaa- Lebanon) that are “ecologically sound”, “socially acceptable” and “technically feasible” following an integrated hierarchical approach described in [1].

Degraded ecosystems are ecosystems that have lost or altered one of their four key qualities: integrity, health, resistance and/ or resilience [2], [3]. Quarrying is a particular type of land degradation involving severe alteration of the topography and removal of substrate (top soil and seed banks) and land cover (habitats, flora & fauna). References [4], [5] confirm that whenever a quarry is abandoned, and exploitation is stopped, natural dynamics are self-initiated but they often fail to sustain the function and the structure of the ecosystems. In most of the cases, developing rehabilitation plans is essential, especially in an urban, semi-urban or rural setting.

The concept of ecological restoration dates back to 1935 [6]

and was defined as “an intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity and sustainability” [2]. Whether intended for restoration, rehabilitation or reclamation [7], [2], any restoration project mainly aims at enabling a degraded ecosystem to regain a functional status along its regeneration pathway [8]. It is therefore possible to either relay on natural processes or prefer an active technical intervention, or combine both while aiming to orient regeneration trajectories [8], or as recommended in [1], include social considerations to reach “ecologically sound”, “socially acceptable” and “technically feasible” options.

Mediterranean ecosystems are characterized by particular climatic conditions (warm and dry summers vs. mild and rainy winters), but also and mainly by an increased human pressure on natural ecosystems (urban development, deforestation, overgrazing, etc.) [9]-[12]. In addition, the hilly topography of the landscapes and the heterogeneity of microclimates induce a high diversity of the vegetation cover and a highly fragmented landscape [11].

In addition to being part of the Mediterranean basin, Lebanon is both as a consequence of its historical background and geographical location, characterized by an important anthropogenic pressure which resulted in the increased presence of degraded ecosystems. It represents a prototype of Mediterranean landscapes with aggravated situations that could serve as a good example to be later applicable to other Mediterranean-type situations [1], [13], [14]. Furthermore, the unstable socio-political situation that prevailed since 1975 has resulted in increased urbanisation, uncontrolled demography and the subsequent irrational development of quarries that were exploited episodically when funds of political support was available [3].

The resulting situation is the existence of more than 1000 extraction sites in the Lebanese territory (10452 km²), i.e. [15] mentions 710 quarry sites, [16] reports more than 1400 and the Green party more than 1700 sites, most of them being either illegal or undocumented. In 1997, the Ministry of Environment issued a decree (8805) regulating the quarrying sector. As a consequence, dozens of sites were left abandoned to undergo a slow and yet uncertain self-rehabilitation [17].

Reference [18] have noted that the preferred option for quarry rehabilitation was the classical scenario (mostly consisting of orchard planted terraces) and have concluded that relying on social sciences, notably cognitive psychology, to help overcome obstacles towards accepting new and more ecological approaches.

Since [19], it is well established that when we interact with

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an object, person and more largely with the environment, we mobilize generic knowledge structures called schemas (also called "frames" [20]; "scripts" [21]; "story grammar" [22]). As [23] showed that if schemas contain a set of knowledge, they contain also information on how to use this knowledge and that communities generally share same schemas. Consequently, there is a circular causality link between behaviors and schemas. Schemas are the source of our behaviors and allow our behaviors to be adapted. Therefore, they are strengthened by our behaviors. In other words, schemas shape the way we see the world, and this is why it is difficult to modify or change schemas.

So, whenever, for political, social or scientific reasons, people are invited to change the way they perceive their environment, we observe a certain form of resistance identified as "resistance to change". It was [24] that first introduced the terminology "resistance to change". References [25], [26] proposed different stages for the adoption of change. The first step corresponds to the decrystallization: abandonment of schemas. The second step is the transition phase where new possibilities are experimented. Finally, recrystallization allows new ideas to automate. But the second and the third steps can only take place if the first one is successful.

The aim of this work is to test the possibility to use knowledge from cognitive psychology to see if we can get a modification of schemas about quarries rehabilitation. The knowledge we are talking about is cognitive flexibility. Cognitive flexibility can be defined as a critical executive function [27] that can be broadly defined as the ability to adapt behaviors in response to changes in the environment [28].

According to the Cognitive Flexibility Theory [29], a person's cognitive flexibility has the ability to quickly restructure their knowledge, hence adapting their responses to changing demands. Moreover, they can conceive a representation of the situation from multiple perspectives.

There is today significant research that shows that fostering cognitive flexibility through appropriate exercises can bring interesting results in learning, for childhood [30]-[32], for adulthood [30] and for older adulthood [33]-[35]. Moreover, [36] have shown that cognitive flexibility is negatively linked to resistance to change i.e. the more flexible an individual is, the easier it is for the individual to change his/ her perceptions.

We state that it is possible to contribute to modify initial perceptions and to accept a "more ecological" suggestion. We test several approaches to compare the contribution of an approach exclusively involving cognitive processes (flexibility) with more conventional and more time-consuming methods (active participation and on the job training). Two experiments were tested. The first experiment involved three different approaches (Training, Flexibility Exercises and Awareness) and the results guided the development of a second experiment combining Awareness and Flexibility.

A. Experimental Approach

Experiment 1: Destructuring initial representations with flexibility.

The aim of this experiment is to test the contribution of cognitive flexibility exercises to reduce resistance to change and induce modification of schemas, while empowering local communities towards adopting an ecological rehabilitation plan for a quarry, in comparison with other approaches (Awareness and Training).

II. SITE DESCRIPTION: MAKNE BEKAA- LEBANON

The quarry is situated near a village called Makne, which is located in the North-East region of the Bekaa Governorate, 30 km from Baalbeck city. The study site expands over a surface area of 28000 m² (Fig. 1).



Fig. 1 Location of Makne and Mdoukha study site

Makne has a registered population of 8,000, but only has 1,000 permanent residents (55% female and 45% male).

Makne is a middle to low class village with an average standard of living. The majority of the community relies on agriculture as a main source of income (olive trees and tobacco plants) [37]. The quarry site is situated at 0.3 km from the village. Before its exploitation, the Makne quarry served as a recreational site for local communities and visitors from the surrounding villages, who used it mostly for picnics and family gatherings. The temporary river was the main attraction, as water flowed for only a few months every year.

The exploitation ended in 2010 and the municipality initiated a process of dumping construction debris in the site. The municipality received funds to undertake the rehabilitation for the abandoned quarry.

A. Participants

This experiment targets the community that is directly impacted by the quarrying activities within a radius of 500 m

of the quarry site. This represents a total of 103 persons, of average 38 years old and a male to female ratio of 3/2, mostly composed of housewives, school teachers, public servants and agriculture workers. These various socio-economic categories are representative of the population in Makne (Municipal data, oral communication 2016).

This study targeted 30% of the total population directly impacted by the Makne quarry (32 persons). They were

divided into four groups of eight persons each and randomly assigned a group (Training, Awareness, Flexibility or Control) (Table I).

III. MATERIALS AND METHODS

Table I describes the different approaches and interventions adopted for the various groups.

TABLE I
DIFFERENT APPROACHES ADOPTED FOR THE 4 GROUPS IN THE MAKNE COMMUNITY

Control (C) 8 Persons	Flexibility (F) 8 Persons	Training (T) 8 Persons	Awareness (A) 8 Persons
Acceptability Pre test	Acceptability Pre test	Acceptability Pre test	Acceptability Pre test
Intervention content: Short documentary on the global environmental crisis.	Intervention content: 20 Flexibility exercises. (e.g. adaptation from Wisconsin test, Tangram, reversible images, optical illusions, Capital R- NR test...)	Intervention content: Eight training sessions on site Topics covered: biodiversity fauna (two sessions), Biodiversity flora (two sessions), Geology, Topography, Hydrology, Landscape integration.	Intervention content: Powerpoint presentation on quarries and its role in the economy, Rehabilitation techniques. Group work drawing of their vision about the quarry site in the future. Identification of threats resulting from "no rehabilitation scenario". Defining objectives of rehabilitation
Duration: 20 min	Duration: 40 min	Duration: 50 hrs over 8 months	Duration: 2 hrs
Acceptability Post test	Acceptability Posttest	Acceptability Post est	Acceptability Posttest



Fig. 2 Traditional rehabilitation (option 1) and ecological rehabilitation (option 2)

All the population concerned by the quarries rehabilitation project (103 persons) was invited to an introductory meeting at the municipality premises (June 2016). Only 78 persons were present. The project aiming at developing a rehabilitation plan for the quarry in Makne was presented and participants were invited to volunteer to participate in an 8 months training on quarries rehabilitation. Only eight persons committed to be part of the training group and the restricted number of persons in each group (8) was dictated by the need for long term volunteering commitment from the persons enrolling in the "Training" group (T). The other groups (24 persons) were selected randomly from the total population.

The authors were involved in this experiment as group animators and performed the programs directly with the participants.

The procedure of the experiment for the different groups is detailed in Table I.

The acceptability test (Fig. 2) represents two rehabilitation options proposed for another site (Qattine quarry) published in [18]. Option 1 showing a classical scenario involving land reclamation including terracing and planting of apple orchards, where option 2 displays a more complex and more

integrated option involving small natural gardens included between the rocky formations. Participants were invited to rate the two options on a total grade of 10 to be distributed among the two options depending on their preferences.

The acceptability test was performed on the participants before (pretest) and after (posttest) each intervention.

IV. RESULTS AND ANALYSIS

Khi-2 tests were performed on the acceptability test on the various groups comparing the scores on the two options between pre and posttests, reflecting their preference for one of both options suggested. The purpose was to identify, for each of the groups, the percentage of persons having changed their preferred choice between option 1 and option 2 in view of the different approaches tested (Fig. 3).

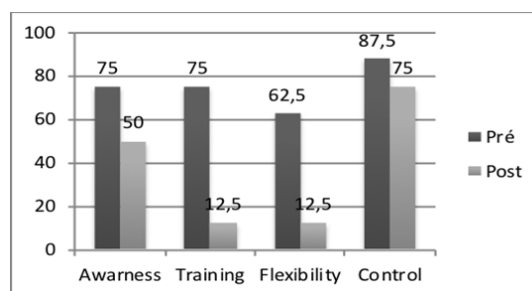


Fig. 3 Percentage of people who chose option 1 before and after interventions

A. Option 1

While comparing the "change of preference" of the various groups with those of the Control group, results show that only

the participants of the groups Training (T) and Flexibility (F) had significantly modified their preferred choice between pre and posttests, respectively, Training vs. Control $Khi2=3.64$, $p=0.05$; Flexibility vs. Control $Khi2=3.04$, $p=0.08$. These two groups had similar choices: $Khi2=0.004$, $p=0.94$. We noticed they modified their choice more than the Awareness group, respectively, Awareness vs. Flexibility: $Khi2=3.06$, $p=0.08$ and Training vs. Awareness: $Khi2=3.14$, $p=0.07$.

Finally, there is no significant difference between the Awareness group and Control group, $Khi2=0.07$, $p=0.79$.

To summarize, the participants in the Training group and the Flexibility group comparably dropped option 1 as their preferred option after the interventions.

B. Option 2

Results (Table II) show that only the participants of the Training group (T) significantly modified their preferred option towards option 2 in the post test:

Training vs. Control: $Khi2=4.5$, $p=0.03$; Training v. Flexibility: $Khi2=5.12$, $p=0.02$; Training vs. Awareness: $Khi2=4.83$, $p=0.02$. Other groups did not significantly change their opinion before and after the interventions (pre to posttest comparison): Flexibility vs. Control: $Khi2=0.66$, $p=0.41$; Awareness vs. Control: $Khi2=0.33$, $p=0.56$; Awareness vs. Flexibility: $Khi2=1.00$, $p=0.31$.

To summarize, only the Training group significantly preferred option 2 in the post acceptability test (Fig. 4).

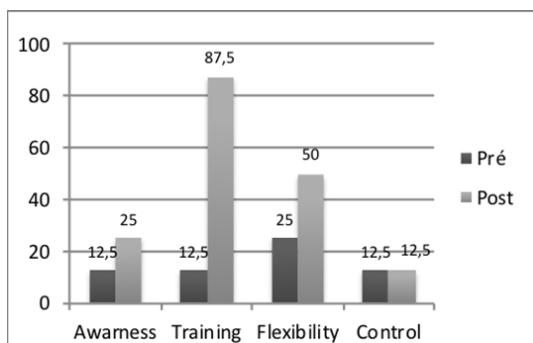


Fig. 4 Percentage of people who chose option 2 before and after interventions

V. CONCLUSION

Results of this experiment show that flexibility exercises contribute equally as participatory training to reduce initial schema. However, reducing the initial schema will only induce the adoption of alternative schema (option 2) for those who have followed the training sessions, but it is important to note that this change occurred after 8 months of training where it only occurred after 40 min of intervention with flexibility exercises.

What would be the effect of combined approaches (flexibility and awareness) towards improving acceptability of ecological alternatives?

Experiment 2: Accepting new representations: combining Flexibility and Awareness

The aim of this experiment is to test the Flexibility contribution to improving the efficiency of awareness sessions towards adoption of an ecological rehabilitation plan for a quarry.

VI. SITE DESCRIPTION: MDOUKHA BEKAA- LEBANON

The quarry (sand pit) is located in the village of Mdoukha located East of Bekaa (at no more than 65 km from the site of Makne, both located in Bekaa district). The sand pit expands over 35,000 m² (Fig. 1) and lies in the middle of a larger landscape fully exploited for sand extraction and sparsely used for grazing. Mdoukha is a middle to low class village, where the majority of the community relies on agriculture main source of income (Municipal data, oral communication 2017).

The quarry site is situated at 1.2 km from the village surrounded by other extraction sites, most of which are still active to date. The site's exploitation stopped in 2015 and the municipality received funds to undertake rehabilitation of the abandoned sand pit.

A. Participants

This experiment targets the community that is directly impacted by the quarrying activities, land owners on nearby plots and the municipality council. This represents a total of 53 persons, with an average 40 years old and a male to female ratio of 3/2 mostly composed of housewives, school teachers, public servants and agriculture workers. These various socio-economic categories are representative of the population in Mdoukha (Municipal data, oral communication 2017).

This study targeted 30% of the total population directly impacted by the Mdoukha quarry (16 persons). They were divided into two groups of eight persons each and randomly assigned a group (Awareness, Flexibility + Awareness) (Table II).

VII. MATERIALS AND METHODS

Table II describes the different approaches and interventions adopted for the various groups.

All the persons living in Mdoukha were invited to an introductory meeting at the municipality premises (April 2017). Only 45 individuals were present. The project aiming at developing a rehabilitation plan for the quarry in Mdoukha was presented and 16 participants were randomly selected to be part of the test groups for this experiment. The individuals were divided into two groups: Awareness Group (A) and Flexibility and Awareness Group (F+A).

The authors were involved in this experiment as group animators and performed the programs directly with the participants.

The procedure for the different groups is detailed in Table II.

TABLE II
APPROACHES ADOPTED FOR THE TWO GROUPS IN THE MDOUKHA COMMUNITY

Awareness (A) 8 Persons	Flexibility + Awareness (F+A) 8 Persons
Acceptability	Acceptability

Pre test	Pre test
Break session	Flexibility session
Duration : 40 min	Intervention content: 20 Flexibility exercises (e.g. adaptation from Wisconsin test, Tangram, reversible images, optical illusions, Capital R- NR test...)
	Duration: 40 min
Awareness session	Awareness session
Intervention content: Powerpoint presentation on quarries, and role in economy, Rehabilitation techniques. Group work drawing of their vision about the quarry site in the future. Identification of threats resulting from "no rehabilitation scenario". Defining objectives of rehabilitation.	Intervention content: Powerpoint presentation on quarries, and role in economy, Rehabilitation techniques. Group work drawing of their vision about the quarry site in the future. Identification of threats resulting from "no rehabilitation scenario". Defining objectives of rehabilitation.
Duration: 2 hrs	Duration: 2 hrs
Acceptability Posttest	Acceptability Posttest

The acceptability test (Fig. 2) represents two rehabilitation options proposed for another site (Qattine quarry) published in [18]. Option 1 shows a classical scenario involving land reclamation including terracing and planting of apple orchards, where option 2 displays a more complex and integrated option involving small natural gardens included between the rocky formations. Participants were invited to rate the two options on a total grade of 10 to be distributed between the two options depending on their preferences.

The acceptability test was performed on the participants before (pretest) and after (posttest) each intervention.

VIII. RESULTS AND ANALYSIS

Khi-2 tests were performed on the acceptability test on the various groups comparing the scores on the two options between - Option 1 pretest and Option 2 posttest, reflecting on their preference for one of both options suggested. The purpose was to identify for each of the groups, the percentage of persons having changed their preferred choice between Option 1 and Option 2 in view of the different approaches tested.

A. Option 1

Results show that participants of the Awareness group did not show any change of choice between pre and posttest contrary to the group that followed Flexibility and Awareness where they changed their choice from option one at post test: $\text{Khi}^2=4.59$, $p=0.03$ (Fig. 5).

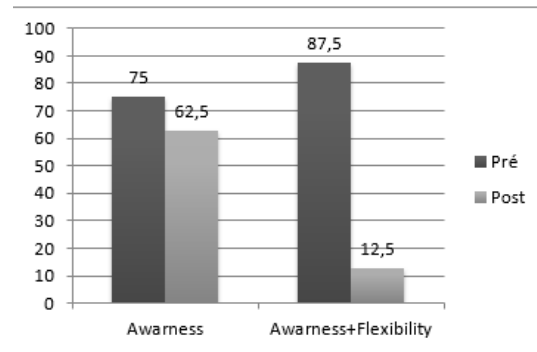


Fig. 5 Percentage of people who chose option 1 before and after interventions

B. Option 2

Results show that participants of the group Flexibility + Awareness chose majorly option 2 at the posttest, while participant of the Awareness group did not modify their initial choice: $\text{Khi}^2=3.57$, $p=0.05$ (Fig. 6).

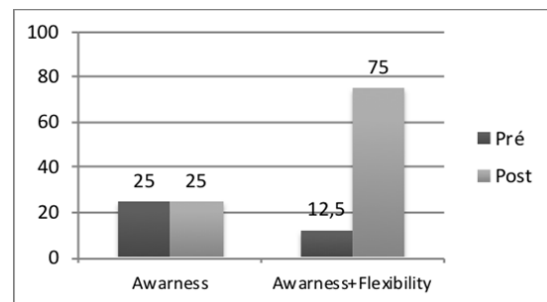


Fig. 6 Percentage of people who chose option 2 before and after interventions

IX. CONCLUSION

Results of this experiment show that not only does the combination of Flexibility and Awareness make participants drop their initial schema; it also shows that they favor the choice of the alternative schema, while participants of the Awareness group did not change their initial schema.

X. GENERAL DISCUSSION

Quarries are a particular type of degraded ecosystem that requires active rehabilitation to face sustained degradation and initiate and orient natural dynamics on the site. In particular, Mediterranean ecosystems are characterized by particular climatic and anthropogenic conditions that make natural regeneration unlikely to reach a proper ecosystems structure and function. Therefore, rehabilitation interventions become more of an obligation rather than a choice [4].

The main objective of this paper is to test several approaches aiming to reduce resistance and increasing acceptability of an "ecological" scenario for rehabilitation versus a more initially preferred classic scenario.

The first experiment aimed to test hypothesis 1 and determine whether it is possible to destructure initial

representations using flexibility exercises to initiate a change in representations towards accepting new alternatives. While the second experiment is based on the results of the first one and aims to test hypothesis 2 related to the effect of combining flexibility with awareness approaches.

In order to test both hypotheses, the methodological approach combined two experiments performed on two populations living near quarry sites in which rehabilitation projects are planned. The two sites are close enough (less than 65 km away) and comparable in terms of socio-economic profiles. The first experiment focused on comparing the reactions of four different groups which undergo four different protocols: 1. Training (T) - 50 hours over 8 months of training on ecological restoration related topics, Group Awareness (A) - 2 hours of project presentation and Group Flexibility (F) - 40 minutes of flexibility exercises versus Group Control (C). The second experiment compared the combination of Flexibility exercises before the Awareness session (F + A) with those of the Awareness Group (A). Comparisons were made on the basis of a choice offered to participants to select between two options for a rehabilitation plan: one depicting a classical scenario versus a more ecological, but less traditional scenario.

Results of experiment 1 show that flexibility exercises contribute equally as participatory training to encourage participants to drop their initial schema; however, dropping the initial schema will only induce the adoption of alternative schema (option 2) for those who have followed training sessions. It is important to note that this change occurred after 8 months of training, while it only occurred after 40 min of intervention with flexibility exercises. Results of experiment 2 show that not only the combination of flexibility and awareness make participants drop their initial schema, but that they also favor the choice of the alternative schema, while participants of the awareness group did not change their initial schema.

Even if both experiments are not totally comparable, we can note that the participants of Awareness group 1 and Awareness group 2 made similar choices at the pretest. Those results show that preset representations in people's minds are conformal with the classical scenario depicted in option 1. However, even if the participants of the Flexibility group drop option 1 (classical scenario), they do not necessarily choose option 2 (ecological scenario). We note that the participants of the Flexibility group are not exposed to ecological information (ecological rehabilitation issues) or environmental issues when compared to the participants who have followed 50 hours of training.

One could argue that the "change in choice" observed in the Flexibility group could result from "social abidance" to the expected outcomes of the acceptability test. However, the results observed in the Control Group (no change in choice) allow us to reject this argument. In order to adopt the correct decision (in this case choose the ecological scenario), information is important, and this can either be provided via participatory training or via awareness sessions. Our results have shown that "opening" people's ability to receive

information via flexibility exercises will influence their choice considerably.

Combining flexibility exercises (40 min) with an awareness session (2 hours) can help in reducing the time to convey the information (via training) and to reach comparable levels of acceptability towards ecological choices.

This paper brings insight towards adopting a methodological approach which is less time consuming and that could be transferred to other environmental problems such as hunting, grazing or environmental management.

The main limitation of this approach is that it requires a high number of participants and it would be interesting to know the time remanence of the results and then repeat the experiments one year later.

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