Use of “Phantom” as a basis for a new form of art therapy in schizophrenia

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Abstract

Art therapy implicates the subject in a first person perspective, and thus arouses the perception of himself as an agent: his agency. Precisely, this sense of agency is altered in schizophrenia, and this impairment is proposed to be the essential etiopathogenic mechanism of schizophrenia. Action-monitoring is knowned as a basis of the sense of agency, through the comparison between the intention and the result of the action (the sensory feedback). In this perspective, we conceived a cognitive paradigm evaluating action-monitoring. We used a virtual reality tool allowing a manipulation of sensory feedbacks. Finally, we put foward the training to those sensory-motor tasks associated to the manipulation of the feedbacks, as a treatment for agency’s impairment. As this tool can be customized for art therapy applications, we propose here a new form of art therapy, based on sensory integration and action monitoring.

Keywords: schizophrenia, agency, self-monitoring, haptic, art therapy.

1. Introduction: the sense of agency

1.1 Alien control and agency

One of the main pillars of mental health consists in continuously maintaining the Self's integrity. Psychiatric disorders such as schizophrenia are characterized by difficulties in determining the boundaries between the external world and the subject. The schizophrenic dissociation comprises many symptoms which all have in common an articulation with the subject's disintegration, psychic disorganization and depersonalization. Certain patients may not feel in control of their movements (as well as emotions, thoughts…) and think that they are a passive instrument in the hands of an external will. They may also believe that they are controlling others' movements. This is what Janet (1937) respectively called the attribution’s trouble by default or by excess. Schneider (1955) characterised those symptoms as first rank symptoms. This ability to attribute the intention of an action to its agent is commonly called sense of agency. Several authors, as Jeannerod (1997) and Frith (1992), consider the disruptive mechanism of agency as one of the essential etiopathogenic mechanisms of schizophrenia.

1.2 “Shared representations” and the “Who system”

Neuroscience provides theoretical explanations, indorsed by empirical results, for those aberrant symptoms. Since the discovery of the mirror neurones by Rizzolatti et al. (1996), and many others which followed, it has been understood that the approximately the same cortical areas – called shared motor representations by Jeannerod (1997) – were activated when the subject is performing, preparing, imaging an action and also when he is observing someone else performing the same action. Therefore, it is a genuine challenge for the individuals to attribute the action to its author. Jeannerod (1997) hypothesized a “Who system” allows the appropriation of the action to its agent.

1.3 Specific treatment of self-produced sensations

The processing of the sensory feedbacks of self-production actions is different from sensory information produced by the external world, as Helmholtz (1967) showed for the vision and Angel (1982) for the touch. Indeed, when the gaze changes its direction, the image of the world moves on the retina but remains still for us. This is not the case when the eyes are moved passively. Moreover, a self-produced tactile stimulus is perceived as less ticklish than the same stimulus generated externally. Thus, in the case of self-produced actions, the sensory feedbacks can be attenuated or even annulated.

Those affirmations are corroborated by neuroimaging. Right inferior parietal, among several areas – which is known to be an indicator of others’ movements (Ruby 2001) – is less activated with a self-produced tactile stimulus compared to the same stimulus generated externally (Blakemore 1998). This area is also hyper-activated in case of a distortion applied to the sensory feedbacks of a self-generated action (Farrer 2003). Likewise, in the apes, Hietanen and Perrett (1996) showed the superior temporal sulcus – STS – is activated in case of passive movements, when seeing other’s movements, but not in case of self-generated movements. Thus, there would be an annulation of the sensory consequences of self-produced stimuli.

1.4 "Internal efferent model"

All these experimental results point the particular treatment set aside for self-generated actions. Ito (1970) and Wolpert (1995) elaborated a theoretical explanation for this specificity: the "internal efferent model". This theory relies on a neurophysiological basis: the existence of a copy of the motor command named the efference copy (Von Holst 1954) and (Sperry 1950). The individual monitor the action by the use the efference copy without waiting for the sensory feedbacks. It enables an anticipation of the consequences of actions, a comparison to the actual sensory feedback, an immediate and effective adjustment of the motor command, and at last, the distinction between the sensory consequences of willed actions and the sensory information provided by the external world. A deficit in this mechanism prevents the identification of the sensory information as a consequence of a willed action, and may have a major effect on the attribution of the action and thus damage the sense of agency.

1.5 Schizophrenia, Agency and "Self-monitoring"

The sub-vocalisations of schizophrenic patients with auditory hallucinations are correlated to the hallucinations (Gould 1949). Thus, the hallucinatory phenomenon is the consequence of an external attribution of the inner speech. Frith (1989) showed the difficulty for schizophrenic patients with alien control to monitor an action without an actual sensory feedback. He came to the conclusion of a deficit of the efficiency of this mechanism which is named "self-monitoring" resulting from a deficit in the use of the "internal efferent model". Schizophrenic compared to normal subjects, need bigger distortions of sensory feedbacks of self-generated actions, to notice the distortion, and thus keep on attributing the action to themselves for a bigger distortions (Daprati 1997) and (Franck 2001).

Moreover, self-produced tactile sensations are not attenuated in schizophrenic patients as in normal subjects, as shows Blakemore (1998). And the right inferior parietal cortex is already hyper activated is case of self-generated actions in schizophrenic patients, as well as when a distortion is applied to the sensory feedback in normal subjects (Spence 1997).

Thus, in schizophrenic patients, some intended acts are treated as the consequence of an external will. According to Chris Frith, the experience of alien control reflects a disorder in the "self-monitoring". Thus Frith (1992), Jeannerod (1997) and many other authors suggest that schizophrenia is pathology of the sense of agency, (including the negative symptomatology). As Proust (1995) suggests, what is defective in schizophrenic subjects is probably not rational thinking, but the self-attribution of intentions. The perception-action loop – the mechanism of self-monitoring are the basis of the sense of agency.

2. Basic methodology: conception of a cognitive paradigm

Monitoring a continuous action, whereas the sensory feedback is alternatively available or absent, involves switching from sensory feedback to efference copy. This should be a paradigmatic illustration of the efficacy of the "self-monitoring". An experimental study of this type should be able to quantify this "self-monitoring" ability. Thus the results of such a study should be an indicator for the subject's sense of agency.

Training patients in switching from efference copy to actual sensory feedback with this disposal should also be proposed to recalibrate the altered sense of agency of schizophrenic patients.

In this paper, we will present a pilot study investigating the potential of "Phantom" material measuring the central monitoring abilities. We measure the performances of twenty control healthy subjects in order to valid this test.

2.1 Subjects

Twenty normal subjects volunteered for this study. None of them reported evidence of neurological or psychiatric problems as assessed by the Mini International Neuropsychiatric Interview (Lecrubier 1997). Other exclusion criteria are an age under 18 and over 35, and familial antecedent of schizophrenia and bipolar disorder.

2.2 Material

"Phantom" is an arm with tactile feedback simulating the palpation of a 3-Dimensional object visually represented on a monitor screen. "Phantom" incorporates the sense of touch into computer applications through force (kinaesthetic) or tactile feedback with a haptically enabled application. With "Phantom" one has an immediate, constant, on line feedback of his movement.

In our experiment, the 3-Dimensional object is a cylinder. The articulated arm enables the user to manipulate a ball. In all sessions, we measure the ability for the subject to make a ball turn around of a 3-Dimensional cylinder without losing contact, as fast as he can.

In a first session, the articulated arm moves at a certain height only. Therefore, the task is made in a bi-dimensional horizontal plane. In a second session, the arm moves in the three dimensions, and a 20mm high ring surrounds the cylinder. The subject is asked not to move the ball outside the ring.

The dependant variables are the number of turns realised in the allowed time and the percentage of time spent in error which are - in both conditions (2D & 3D) - the percentage of time spent without contact between the ball and the cylinder, and - only in the 3D condition - the percentage of time spent outside the allowed ring.

Subjects pass two conditions in the 2D as in the 3D tests. In the first condition, the ball is continuously visible except in the rear-side of the cylinder. When the ball goes from the front-side to the rear-side, visual information is lost, and a few schizophrenic patients have developed experimental delusion of control. In the second condition, we introduced a discontinuity in the visual feedback. The ball is alternatively visible or invisible.

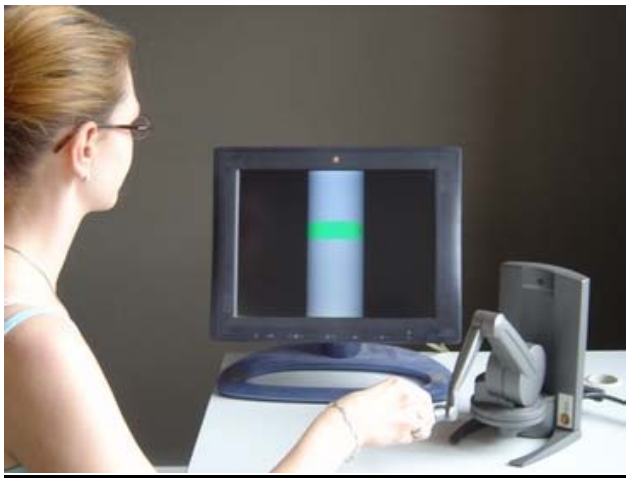

Figure 1 Subject performing “Phantom”

2.3 Design

The experience is about 20 minutes long. It is composed of 22 tests (each one lasts 45 seconds), split up into two sessions. In the first session, subjects pass the 2D condition. They first discover the device in an acquisition phase composed of three 2D tests with a continuous visual feedback. Then, subjects take eight tests: one half has a continuous feedback and the other half has a discontinuous feedback, according to the following design:

For one half of the subjects:

Discontinuous	Discontinuous	Continuous	Continuous	Discontinuous	Discontinuous	Continuous	Continuous

And for the other half:

Continuous	Continuous	Discontinuous	Discontinuous	Continuous	Continuous	Discontinuous	Discontinuous

In the second session, subjects pass the 3D condition. They first discover the 3D application in an acquisition phase composed of three 3D tests with a continuous visual feedback. Then, subjects pass eight tests: four tests have a continuous feedback and the four others have a discontinuous feedback. The subjects pass those 8 tests according to the same design described in the 3D session. The subjects beginning with the continuous condition in the 2D session are also beginning with the continuous condition in the 3D session, and similarly for the ones beginning with the discontinuous condition.

We compare the performances (number of turns realised and percentage of time spent in error) of the continuous and the discontinuous conditions, within the 2D and the 3D sessions. According to our hypothesis, those differences indicate the disability of monitoring an action due to a discontinuous visual feedback, and thus indicate the capacity of central monitoring.

2.4 Perspectives

This test is now validated in healthy subjects. We are able to test the performances of schizophrenic patients and to compare them with the ones of the control subjects.

To a larger extent, we expect to continue those experiments in order to prove that training schizophrenia patients at "Phantom" tasks with a discontinuity in the sensory feedbacks participates in recalibrating their altered sense of agency. This hypothesis will be further investigated in a longitudinal study.

This application can be improved in a task asking multimodal sensory integration abilities to the subjects who perform it. The delimitation of the ring can be at the same time haptic (the texture along the ring is smooth whereas it is rough outside), visual (the ball is visible, the ring is colored) and auditory (meeting the ball with the cylinder inside the ring, gives a continuous tone whereas passing over the band or losing contact with the cylinder doesn't provoke any sound). Initially, all sensory feedbacks are provided. Then, while performing the task, roughness, tone, ring's coloration or ball's visibility can be suppressed and reintroduced and those modifications are unpredictably iterated, while the subject is performing the task, so that he doesn't expect it. This kind of task asks the subject to switch, not only from a sensory feedback to an efference copy but also from a sensory channel to another one. This could be another track to treat the altered sense of agency of schizophrenic patients.

Thanks to its easiness of creation of applications, "Phantom" can also be used as a tool for art therapy.

3. Art, agency and perception-action loop

What is therapeutic in art therapy programs? It is a common assumption that Arts involves high cognitive abilities, including high levels of outside world and self-representations. Thus, the efficacy of art therapy merely lies in a catharsis through a free expression of the Self. Art therapy allows an exploration of the patient's inner world in a non-threatening way through a therapeutic relationship for people for whom verbal psychotherapy would be impossible.

But isn't there a place for more basic mechanisms? Isn't artistic creation also an experience deeply rooted in the perception-action loop? For example, feeling the paintbrush touching the canvas, feeling the bow brushing a violin string… Performing art (as any sensory-motor tasks), constantly implies the perception-action loop.

Of course, those two levels of processes are implied while performing art, and both concern the first person in action. Making a piece of art requires initiatives, and enables comparison of the final result with the initial goal which allows a subject to attribute his creation to himself. Art performances specially illustrate those two levels of the sense of agency.

As shows the latest review of literature about art therapy for schizophrenia patients (Cochrane Collaboration 2006), there are very few evidences for an efficacy of art therapy. The authors emphasize on the lack of randomised studies. Maybe should we also try new strategies based on new theoretical approaches?

4. Proposal of "Phantom" as a basis for art therapy

We focus on the fact that the therapeutic mechanism of art therapy could also get trough a rehabilitation of the perception-action loop using sensory-motor tasks. Using "Phantom" implies more strongly the self-monitoring of the action, especially when it comes multimodal and sensory feedbacks are modulated. We suggest that the multiple applications which can be associated to "Phantom" illustrate this reduction of art to one of its component: the perception-action loop and should be used in art therapy program. In this reductive conception of art therapy, creativity wouldn't anymore be the aim, but would become the means. Creativity would be a means to make "Phantom" training ludic, playful, in order to interest the subject, to excite his curiosity.

One of the original applications of "Phantom", as it is commercialised, is in the artistic sector, such as painting, sculpting, CAD...

It is easy to create multiple applications with "Phantom". Such applications as reproduction of drawings, with a tone indicating the subject is going out of the line can be created.

Moreover multimodal sensory integration can be easily proposed. In a painting application, colours can be chosen and applied on a virtual canvas. They can be associated to tones. As well, "Phantom" can be used as a tool to sculpt a virtual piece of wood, and tones can be associated to deepness of the erosion. Though, subjects get more than only one sensory feedback to monitor their action. Those feedbacks can be alternatively and suppressed then reintroduced and this can be constantly iterated during the art performance. Thus, subjects will be trained to switch from a sensory channel to another, a feedback to an efference copy, and, according to our hypothesis, would train their agency's skills.

Figures 2, 3 and 4 Examples of virtual pieces of art

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