Practising Active Science With Child Refugees: A Clinical Perspective

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Abstract

In this paper, pilot sessions in Rwanda and Nepal are analysed to evaluate the therapeutic benefit of active science for traumatised child refugees. The nature of the activities, choice of tools, organisation of the sessions, group size, and the role of the educators are investigated. Despite the lack of quantitative assessment, practical suggestions and theoretical issues emerge. Activities favouring integrated projects and affective dimensions, such as becoming familiar with insects, dinosaurs, or planet watching, are able to induce positive attitude changes. Large models, built during the sessions and decorating the setting, and small objects that can be taken away, support a recovery process by containment and symbolisation of the inner psychic sanctuary. The most important therapeutic aspect seems to be the opportunity for reactivating curiosity and creative play, and for experiencing the joy of discovery. The inferred recommendations could be relevant in a wide range of circumstances, including psychosocial intervention after war trauma, rehabilitation of street children or child soldiers, as well as paediatric hospital settings.

Introduction

Caring for Child Refugees

War, genocide, natural disasters and extreme poverty, on all continents, keep producing throngs of victims, including children, in extreme states of physical and psychological distress (e.g., Dyregrov, Gupta, Gjestad, & Mukanoheli, 2000; Kuterovac, Dyregrov, & Stuvland, 1994; Paardekooper, De Jong, & Hermanns, 1999; Pearn, 2003; Pynoos et al., 1993; Yule, 2000). Although it was a concern even before the beginning of the 20th century, and especially during and after World War II (Jensen & Shaw, 1993), the interpretation of symptoms after massive violence and the associated therapeutic strategies remain controversial issues, especially in the case of children (Barnett, 1999; Bracken, Giller, & Summerfield, 1995; Eldebour, Bensel, & Basstien, 1993). The concept of post-traumatic stress disorder (PTSD), a syndrome unifying several recurring pathologies (e.g., Davis & Siegel, 2000; Yule, 2001), has been extensively used during the last two decades to encompass, with depressive disorders, most of the immediate and long-lasting effects of extreme traumatic events (e.g., Bolton, O'Ryan, Udwin, Boyle, & Yule, 2000; Udwin, Boyle, Yule, Bolton, & O'Ryan, 2000; Yule et al., 2000). The validity of PTSD has been checked, to some extent, in different cultural environments (e.g., Sack, Him, & Dickason, 1999; Servan-Schreiber, Le Lin, & Birmaher, 1998). However, fundamentally, basing assistance programmes on psychological models derived in the context of Christian western societies may be inadequate (Dahl, 1989; Spouse, 1999), and even detrimental in other cultural settings (Summerfield, 1999, 2000). Verbalisation of trauma, for example, was found to exacerbate negative effects in a study of child refugees from Bosnia (Angel, Hjern, & Ingleby, 2001). Equally misleading could be an approach where child refugees, in essence, are considered resilient, and would not require dedicated external support. Indeed, lack of symptoms among child war refugees does not mean well being (Jones & Kafetsios, 2002), and even apparent resilience is not incompatible with suffering (Calhoun & Tedeschi, 1998).

In view of the lack of paradigm, it is legitimate to base therapeutic approaches on general empirical principles. While their associated theoretical constructions remain questionable, models such as client-centred therapy (Rogers, 1957), squiggle (Winnicott, 1971), or child psychoanalysis (Mannoni, 1967) definitely originated from decades of direct experience with patients, and often resulted from personal war or genocide experience (e.g., Bettelheim, 1943). In practice, intervention programmes make use of the large body of psychiatric and psychological knowledge, and try to address the emergency needs in reasonable and ethical manners (Kinzie & Boehnlein, 1993), given the often difficult circumstances (Dybdahl, 2001). Some therapies require the verbal expression of the traumatic experience, and some rely on drawings or play (e.g., Cohen, Mannarino, Berliner, & Deblinger, 2000; Yule & Canterbury, 1994). Common goals of the various approaches are to avoid psychiatric disability, to alleviate the long-term effects of the trauma (e.g., Schreuder, Kleijn, & Rooijmans, 2000), and to promote psychosocial restitution (Silove, 1999) and even resilience of the child refugees (Monaghan-Blout, 1996; Rutter, 1985, 1987, 1999).

Supporting Child Refugees With Educational Programmes

Among possible therapeutic pathways, educational approaches appear particularly important in the case of children. Constructivist educational methods (Martin, 1999) which, through a helping and caring relationship, aim at inducing learning and at developing the desire to learn, create situations which are essentially similar to therapeutic environments (Rogers, 1959). Such educational principles offer an interesting approach in many psychiatric diseases as well (Mannoni, 1967). However, such approaches, at least until recently, have focussed on activities such as tailoring, gardening, printing, or artistic activities such as sculpture and painting.

The social value of scientific education, including the observation of natural phenomena, was pointed out long ago (Soëtard, 1995) and, recently, in the renewed wave of hands-on science education, this aspect was explicitly emphasised (Lederman, 2001). Indeed the children, by performing experiments, become familiar with the scientific processes, and can experience the joy of discovery. Such happenings must have a significant therapeutic value (Rogers, 1974), as reviving the intrinsic curiosity of children following trauma must also revive interest in life. Meaningful experiences of scientific activities have been carried in shelter homes in the United States (Barton, 1998 and references therein), but few attempts have been reported with child refugees.

Goals of the Present Study

In this paper, active science sessions performed in Rwanda in 2000 (Perrier & Nsengiyumva, 2003) are compared with subsequent sessions performed in Nepal from 2000 to 2003. In the light of this second experience, some assumptions are re-evaluated. The sessions are analysed here with an emphasis on the clinical perspective, with an attempt to draw general conclusions.

The paper proceeds as follows. First, the sites, the sessions, and the experimental methods are described. The main observations are then presented. After discussing possible interpretations and raising theoretical issues associated with the therapeutic process, practical recommendations for intervention with child refugees are gathered in the conclusion.

Description of the Pilot Active Science Sessions

The Sites and the Children

Pilot sessions were performed in two different settings: one orphanage sheltering child refugees from the 1994 genocide in Rwanda, and one children home in Nepal. An overview of the sessions is given in Table 1.

Table 1
Overview of the Active Science Sessions Analysed in This Paper

Location	Dates	Number of groups	Age	Number of children per group	Number of sessions	Main topics of the sessions
Ruhengeri	Oct to	1 (A)	16-18	7	ZS[a] + 7	Platonic solids
(Rwanda)	Dec	1 (B)	12-16	11	ZS + 4	Plant extracts
	2000	1 (C)	9-13	11	ZS + 4	Insects and spiders
Kathmandu	Dec 2001	1	11-13	3	ZS + 3	Moon and planets
(Nepal)	To	7	8-11	3	ZS + 4	Dinosaurs
	Jan 2002	4	13-15	3	ZS + 4	Electricity
		2	14-16	3	ZS + 2	Food science
	Dec 2002	4	9-12	5	ZS + 3	Solids and insect models
	To	3	10-13	5	ZS + 6	Electricity
	Jan 2003	3	14-17	5	ZS + 7	Electronics
		1	9-13	5	ZS + 3	Seeds and plants
		1	12-14	5	ZS + 6	Solar system

[a]The Zero Session (ZS) is an introductory game that preceeded the other sessions.

Although located in different continents, affected by widely different political and historical contexts, these two sites share common features: an overall difficult economical situation, with a major fraction of the population living in extreme poverty in remote mountainous rural areas. Urbanization rate is indeed among the lowest in world, 6 % for Rwanda and 12 % for Nepal in 2001, as is the Gross National Income (GNI) per capita--220 USD for Rwanda and 250 USD for Nepal (UNICEF, 2003). In the last 2 years, however, definite improvements have been taking place in Rwanda, while institutional instability is causing accelerated impoverishment in Nepal. The two countries also share a distinct language and a unique culture.

Sixteen sessions were performed in Rwanda from October to December 2000, in an Un-Accompanied Children Centre (UACC) located in Ruhengeri, in the Virunga volcanic mountain range (Perrier & Nsengiyumva, 2003). This UACC shelters orphans from the 1994 genocide and subsequent events, including the on-going civil warfare in nearby Congo. Some orphans were admitted directly after being found homeless, sometimes after living several months in the forest, and sometimes after several years in the streets (Veale & Dona, 2003). Some orphans were also admitted after the closure of other centres. In almost all cases, reunification with the family was not possible and the experience of violence and trauma exposure had been extreme (Dyregrov et al., 2000). Sessions were performed with one group of male teenagers (Group A) and with two groups (B and C) comprising both boys and girls, as shown in Table 1. The participants of Group A were selected by the manager of the UACC. Most participants of Groups B and C were selected by the author. Three children were admitted at their request. The children suffered from poor hygiene due to chronic lack of water, insufficient food supplies, overpopulation of the UACC, and the prevalence of malaria and tuberculosis.

In Nepal, more than one hundred sessions were performed in a children home opened in 1993 in the suburb of Kathmandu. This shelter home includes a school, registered in 1998. Some children living in the home are orphans but most children still have either father or mother, sometimes both, although the relationship could not be restored in about 10% of the cases, in agreement with published reports (Baker, Panther-Brick, & Todd, 1997). Some children were found, by the managers of the home, living in the streets, or were referred to the home by other international or local organisations after natural disasters such as floods in the plain areas or community violence in Nepal or nearby Bhutan. Although the trauma exposure cannot be compared with the events of Rwanda, most children have experienced extreme poverty, abandonment, threat to survival, and some forms of violence and abuse of varying duration, in most cases for several years. The health situation in this home is considerably better than in Ruhengeri.

More than 50 sessions were performed in Nepal during December 2001 and January 2002, with 14 groups of three children each (Table 1). In December 2002 and January 2003, more than 60 sessions were performed, with groups of five children each, including essentially all the children who had participated the previous year plus newly admitted small children (boys and girls). In both sets of sessions, all participants were volunteers and the groups were composed by the children themselves. Additional informal preliminary sessions were also conducted in Nepal from July to September 2000.

Theoretical Framework for the Active Science Sessions

While the current debate (e.g., Scarff Seatter, 2003; Watts, 1998) on the use of Piagetian constructivist theories, and their undeniable practical pitfalls, lies outside the scope of this paper, it is necessary to define more precisely what is meant here by active science. Active, inquiry-based, and hands-on science are generic terms used with meanings that do not necessarily coincide (Hofstein & Lunetta, 2004; National Research Council [NRC], 1996; UNICEF, 2003).

The activities during the sessions were based on simple experiments that the participants developed from their own thoughts, using materials from their immediate surroundings, with minimal interference and guidance from adults (Martin, 1999). Rather than the actual experimental achievements, the main aim of the sessions was to initiate discussions between the group members and the adults, between members within a group, and between the groups. Science emerges then more as an attitude and a way to progress step after step, than a catalogue of God-given

knowledge. The activities thus were not restricted to hands-on manipulations, but designed to support minds-on experiences, in agreement with current recommendations (NRC, 1996). Conceptualization, however, was not the goal here. Incidentally, it may be pointed out that it is not obvious that it has to be necessarily the case in a regular educational setting. In our context, the actual scientific value of the sessions is clearly less important than the promotion of happiness and the associated expression of therapeutic feelings.

Going further in this direction leads to the incorporation of relevant issues raised, in the context of social cognition models, by Lev Vygotsky (Ivic, 1994). Following Piaget, scientific concepts in children are divided into spontaneous concepts, which are tightly connected to everyday experiences, and non-spontaneous concepts, which correspond to accommodated and assimilated knowledge (Vygotsky, 1934; Piaget, 1969). However, instead of the Piagetian progressive phased development, a more dynamical view of the interaction between spontaneous and non-spontaneous spheres is proposed (van Geert, 1998), with two key concepts (Vygotsky, 1934). First, cognitive development results from social interactions and cooperation with teachers and peers. Second, it occurs by the internalization of processes performed first with the help of others in the interaction zone referred to as the zone of proximal development (ZPD). In this socio-cultural view of learning, the sociological function of science is emphasized. While science represents ultimately an opportunity for social recognition, it offers, first of all, a reason to talk, to discuss, to show things, to argue, and to interact with peers. This value of scientific learning has been pointed out in the context of science activities performed in shelter homes in the United States (Barton, 1998) and should also be considered as an important background backbone of our sessions.

With traumatised children, an important goal of any activity should be to restore the normal development processes of the children. For this purpose, the interaction of spontaneous and non-spontaneous concepts must play an important role. Active science sessions should therefore aim to restore first the spontaneous concepts, with the re-creation of curiosity, re-creation of a relationship with the material world and its externalization, and then the ability to work in the ZPD for the internalization of non-spontaneous concepts, thanks to the support of positive feelings and shared happiness. This constitutes the tentative elaboration of the theoretical foundations of active science for the purpose of this work.

Organisation of the Sessions

Sessions in Rwanda were performed twice per week with Group A and once per week with Groups B and C. In Nepal, during the first set (2001-2002), the routine was one session per week, and sometimes one session every 2 weeks. This was a consequence of having a large number of groups (14) with only three children in each session. During the second set (2002-2003), although the total number of participants was larger (60 instead of 42 the previous year), a routine of two sessions each week could be maintained because groups included 5 participants instead of 3, and because sometimes two groups were working simultaneously.

The timing and duration of the sessions was different in Rwanda and in Nepal. In Rwanda, sessions took place from 2 p.m. to 5 p.m. for group A, and from 5 p.m. to 7 p.m. for groups B and C, whose participants were in school before 5 p.m. In Nepal, sessions were 1 hour long and took place from 1 p.m. to 5 p.m. during the first set. During the second set, sessions were 45 minutes long and took place from 3 p.m. to 5 p.m. in order not to interfere with the school routine.

Both in Rwanda and in Nepal, the sets of sessions were preceded by a game (Perrier & Nsengiyumva, 2003) called the Zero Session (ZS). The goal of the ZS was to make a first contact, to create a joyful atmosphere, and to introduce the children to active science. This session included identification games (identifying objects from their sound in a box, or by touching objects hidden in a bag) and graded questioning. The purpose of these games was to evaluate the learning modalities of the participants and their pattern of participation, identify pathological behaviours, and to raise, in an introductory manner, the scientific questions that were to be investigated by the children during the subsequent sessions.

The Topics of the Active Science Sessions

In our sessions, no explicit divisions were drawn between the various branches of science. Instead, the topics were approached in an integrated manner. Some topics favoured this path more than others.

In Rwanda, in the remote Ruhengeri area just emerging in 1999 from years of brutal warfare, little recycled material and waste products were available, and consequently sessions had to be adapted to make use of plants, insects, spiders, and bamboo sticks that could be purchased from the local market. Various activities were performed with the teenagers Group A (Table 1), with an initial momentum given by the construction of the five Platonic solids (Tetrahedron, Octahedron, Cube, Eicosahedron, and Dodecahedron). Basically, the group members had to find the five solids by themselves and convince themselves that no other regular solids are possible. The resulting symmetries were then studied in other objects from the physical and the biological world, including flower petals, leaves, and, last but not least, the football!

The Mayow experiment (Martin, 1999) was introduced with Group A in the course of a discussion of respiration, forces, and energy which followed an outdoor practice of breathing exercises from Martial Arts. In this experiment, a candle is placed over a water container, is lit, and then covered with a slender jar. The water level in the jar rises after the candle goes out. This experiment definitely captured the interest of Group A members (Perrier & Nsengiyumva, 2003), who invented several variants. For example, several candles of the same height, or of different heights, were placed in the jar. The size of the jar can also be varied, and the candle can also be placed floating on water so that the flame is kept at a constant distance from the water level. Several tricks, such as introducing a siphon to change the relative level of water inside the jar compared with the outside container, were actually described in the original paper (Mayow, 1674). This is an example of how active science tends to drift away from the cold, and sometimes inaccurate description of, experiments provided by textbooks, and instead recreates the discussions, the questions, and the excitement present in the original reports.

With Group B, various dyes were invented, using petals and leaves dipped in either water, alcohol, or oil, producing both conventional and less conventional colours and smells. Various mixtures, miscible and non-miscible, were also freely tried, with students demonstrating a clear preference for edible ingredients. Group C learned to trap insects (mostly mosquitoes and fruit flies) and spiders alive, and then discussed the various systematic differences between insects and spiders, such as the classical counting of legs, body parts, and wings. In this tropical context, the inquiry was designed to allow the participants to learn the difference between female and male mosquitoes from the antennas, and learn to distinguish *Anopheles* mosquitoes (carriers of malaria parasites) from *Culex* mosquitoes (non-carriers). This is practical information, as the spread of malaria is one major health problem in Rwanda (most participants actually had malaria themselves). In Nepal,

this activity was performed in a different manner because a microscope was provided and more time was available to observe the various larval and pupal stages. It was possible to observe the birth of both male and female mosquitoes from the pupae, whereas mostly females were captured in the home. Both in Rwanda and in Nepal, small models of insects and spiders were built with wood, mineral water bottles, and table tennis balls.

Because of the much larger number of sessions performed in Nepal, more topics were attempted (Table 1). Food science, quite popular because of the leftovers from the sessions, included studying the differences between various fatty acids and the density of various solutions, as well as analysing Vitamin C content using iodine, with an absolute calibration using tablets from the local pharmacy. Electricity involved playing with switches, resistors, bulbs, and batteries, and led to a more technical set of electronics sessions during which oscillators, buzzers, a small electronic organ, and a small solar car were assembled. Star watching in the evening lead to activities about the moon and the planets. Experiments were performed with sand balls to illustrate the origin of craters, and ultimately a small solar system was constructed. The activities with dinosaurs included building paper models of *Allosaurus*, *Triceratops*, and *Brontosaurus*, digging out dinosaur bones hidden in clay bricks, and using toys and card games commercially available from science museums.

Methods and Instruments for Data Acquisition

Before and after the sessions, information was collected about the children from both the staff of the centres and the organisations working with the children. This collection of information was difficult in Rwanda, as most children did not trust adults and did not disclose information about their history and their village. In some cases, the children themselves, too small at the time of the 1994 genocide, did not know where they came from. Some participants suddenly talked about their hill during the sessions, but it was not possible to come back to the topic after the sessions. (Rwanda is known as “the land of the thousand hills.” People don’t talk about their home or village but rather their hill, which is both, and more.) One girl also admitted that she had lied to all social workers about her background, and she declared that she would not tell the truth because she was happy in the orphanage, and did not want to be reunified. The children were apparently functioning during the sessions, but attention deficiency with hyperactivity (ADHD) (American Psychiatric Association [APA], 1994), indifference (avoidance and numbing), and repetitive play, as well as depressive or phobic disorders, usually associated with post-traumatic stress disorder (PTSD) (Green, 1994), were regularly observed, and sleep disturbances were repeatedly reported.

Collection of information was comparatively easy in Nepal, as the managers of the home often knew the children’s backgrounds and family situations from first hand experience. The author was therefore informed about the children who had been at risk, and those children who were having recurrent behaviour problems or pathologies such as encopresis or enuresis.

During the sessions, significant behaviours of the participants were noted in a log book. In Nepal, a data base was also gathered on the participants, and this included their learning modalities from various tests (Martin, 1999), poems, drawings, and dreams that had been mentioned. The participants also completed questionnaires. This work is continuing and will be reported elsewhere.

Material was collected to monitor the content and development of the sessions. This adaptive strategy was implemented both in Rwanda and Nepal, and was based on debriefing discussions, after each session, with the caretakers of the children and other social workers involved with them.

In Rwanda, children needing special attention, such as mentally handicapped children or those with symptoms of autistic spectrum disorders, were referred to professional therapists. In Nepal, discussions also involved class teachers and elected representatives of the children. Following these discussions, groups were sometimes recomposed, work was divided during the sessions in subgroups with selected children, and the topics were changed if complaints had been expressed. These discussions, along with the resulting adjustments during the sessions, were probably the main therapeutic tool associated with the whole experience. The children knew that these discussions were taking place, and they knew that the science sessions were dedicated to them. While most children, both in Rwanda and Nepal, claimed they did not care much about anything, some of them expressed clear satisfaction for being at the centre of a lot of attention.

Observations and Results

Response of the Participants

Overall, the response of the participants during the sessions was enthusiastic. In Rwanda, the teenagers in Group A were suspicious and distant at first, but finally changed to positive attitudes and formulated expectations (Perrier & Nsengiyumva, 2003). Younger children showed a tremendous desire to learn how to do things. They always wanted longer, and more numerous, sessions. They did not miss any session, and some came even when sick (malaria fits), and would keep hanging around after the sessions. In Nepal, the impact of the sessions could be observed. Many children continued the activities by themselves, books were taken from the library, and many objects in the centre were being dismantled and investigated.

Both in Rwanda and Nepal, the Zero Session (ZS) met consistently with an astonishing success. This session, noisy and chaotic, definitely set a new atmosphere for the participants who are used to, in both countries, quasi-military discipline and seeing a large distance maintained between them and their teachers. In Rwanda, the whole set of sessions was powered by the initial excitement of the ZS. Behaviours noticed during the ZS were also significant, as participants who showed restraints during the ZS expressed problems during the subsequent sessions, such as depressive states, ADHD, or antisocial behaviours.

Impact of the Scientific Content of the Activities

The activities practised during the sessions were in general adequate, but some activities appear more popular than others. Some classical hands-on topics of regular school settings (Cunningham & Herr, 1994), such as playing with a pendulum or pulleys, did raise interest, but did not create as much excitement as electronics and astrophysics (the top two subjects for teenagers) or electrical insect traps and dinosaurs (the top two subjects with smaller children). The keen interest of children towards insects, reported previously by Shepardson (2002), is confirmed here in widely different contexts. Discussing dinosaurs in Nepal was estimated by numerous teachers and adults as a strange idea, but the children, probably more familiar with dinosaurs than the adults thanks to the Spielberg movies, were totally excited while handling dinosaur bones or building dinosaur cardboard models.

The lesson that can be drawn at this point is that it is useful for such activities to build on previous interest of the children, rather than making a priori assumptions on what they have to learn. This is certainly in agreement with the constructivist point of view (Martin, 1999), but it is more the previous interest of the children, rather than their previous knowledge, that should be the focus of

attention. Also, whether in the mountains of Rwanda or Nepal, all children have heard radio and seen magazines, and it is inappropriate to think that they know nothing of the western modern world and will be satisfied with learning about rice plants and handling bamboo sticks. This does not necessarily imply that they are not interested in these subjects, but the active science sessions should be made special moments that they shall remember. Therefore, the topic has to be attractive and fantastic to them--one they should dream about.

However, traditional activities, such as the pendulum mentioned above, should not be abandoned. Swinging a pendulum, measuring periods as a function of length, investigating the effect of the weight size, mass, and initial swing amplitude, are fruitful and illustrate important points of the scientific approach. However, in order to meet its goal, this activity has to be introduced at a proper timing in this setting and, if possible, at the request of the participants. Asking the children to swing a pendulum, and fill predefined checklists with predefined conclusions that they are programmed to reach in predefined order, is likely to be boring to most of them, and to have a limited impact, if any at all. In general, manual activities derived from a traditional school framework, even when plastered with an artificial hands-on facelift, and often no more than a reluctant tribute to fashion, are not adequate. This is especially true for a therapeutic setting because, in the end, what the children learn is not important, and the only evaluation is whether or not they like it, and whether the sessions made them happy.

Some topics offered during the pilot sessions should be studied in more detail. The building of the Platonic solids was definitely a risky endeavour with the Ruhengeri teenagers. However, although disaster and rebellion were avoided on a tight rope, success was met, surprisingly enough. The mistake was probably to concentrate the activity on the Platonic solids, whereas another theme such as the football should have provided the starting point. At the same time, the huge satisfaction experienced upon completion of the five solids, beautifully arranged in the courtyard of the orphanage, suggests that the activity by itself contains a tremendous internal power, especially in a therapeutic framework. This definitely implies that mathematical, more abstract, constructions should not be eliminated at the benefit of fashionable subjects or purely practical and technical activities. The preliminary sessions thus indicate that the success of the sessions, in terms of long-term impact, relies on a combination of prior interest, initial excitement, and a deeper, internal, personal experience.

Choice of Experimental Supports and Equipment

The choice of materials selected for the sessions has more importance than was anticipated. In Rwanda, a basic principle was to rely only on waste products and recycled objects. It was a useful experience for the author to achieve results when little or nothing is around, but the teenagers and children of Ruhengeri had to manage from morning to evening using whatever they could find, and they certainly did not need further training in this respect. The need to purchase some basic material became clear, though. It was actually worthwhile to devote some time to shopping trips, although they were time consuming and not without risks, given the overall state of insecurity. Indeed, the trips to the market with Group A were precious, friendly moments, and they provided a perfectly acceptable justification to get out of the orphanage, an important fact also pointed out by workers in other settings (Barton, 1998). Bringing instruments from abroad is also important. Indeed, one local professor expressed scepticism about the "trash only" approach, which he called brainwashing, claiming that it was just an excuse to keep the country backward with "second class science." The Ruhengeri children definitely would have enjoyed seeing a few instruments, even

basic and cheap ones. In general, they were eager to be taken seriously, and appreciated all signs that could be interpreted as such.

Consequently, in Nepal, although the equipment remained based on trash and objects of daily life, a few instruments were introduced--simple multimeters, one microscope, and one telescope. The enthusiasm of the children was overwhelming, and the financial investment was actually minimal. Moon and planet watching became a routine in the evening, even with children as small as 6 years of age. Questions showered, leading to an attitude shift pervading subsequent sessions. Beyond the vast areas for investigation, opened by the microscope and telescope, which immediately allow physically following the footsteps of Galileo and Leeuwenhoek, these instruments are not without beauty and bear a strong fascination and imaginary power which are probably of major importance for our application.

The objects manipulated during the sessions therefore have to be selected with utmost care. On the one hand, it is important that, through questions and answers and an inquiry-based approach, the children produce their own scientific objects, such as insect traps made from mineral water bottles and cardboard. On the other hand, participants should also be introduced to real instruments, including computers. The design of the sessions in developing countries should not be different to that in the developed western world.

Number of Children in a Group and Frequency of the Sessions

The number of sessions that can be performed with a group depends on the total time available, the total number of children, and the number of children per group. In Rwanda, because of time constraints, the number of participants per group was large (7 to 11, see Table 1) and, during the course of the sessions, the work took place within smaller subgroups. In Nepal, smaller groups were considered, with 3 or 5 participants. The reason for favouring smaller groups was to be able to concentrate on all children, and this is obviously harder with larger groups or when several groups are working simultaneously.

Both in Rwanda and in Nepal, the participants complained that one session per week was insufficient. With 3 children per group, the number of groups was too large and the routine of one session per week could not be maintained for all groups, although sometimes two groups could be handled simultaneously. A good compromise, allowing efficient work and enough attention, seems to be 5 participants per group, and two sessions per week.

Duration and Timing of the Sessions

Sessions were 2 hours or longer in Rwanda. It was actually not too long, even with the younger children, who actually never wanted to stop, and the sessions were terminated in darkness, in the absence of electricity, with the dim light of a few candles. In Nepal, a different strategy was tried--the sessions had a fixed duration of 45 minutes, but were open-ended. The children were free to stay and to continue if they wanted. This way of working came spontaneously over the years, and seems to provide satisfaction.

In any case, the timing has to be made clear to participants, so they know when they may leave if they wish. Specific time has to be scheduled for safety instructions and clean-up. Some time also has to be saved after the sessions are officially over, during which the adults are available to chat with the children.

Management of the Sessions

The role of the adults during the sessions needs to be clarified. As with any constructivist activity, active science sessions are performed by the participants themselves, with the adults remaining in the background, interfering as little as possible (Martin, 1999).

Both in Rwanda and Nepal, the sessions were conducted in a free atmosphere and the children were free to shout, have fun, enjoy themselves, and be noisy, although at times this led to minor friction with the local caretakers or the neighbours. In general, the scientific spirit of the sessions was not strict. The children have to be children first, and they have to be free to do their activities in their own way, collect their own little things, and play with them as toys and not as instruments. Even when the activities did not turn out as they might have, at least from a pedagogical content point of view, the children were not forced to do what may otherwise be expected. They could take things away and distort the original ideas of the designers, sometimes improving them and sometimes making a real mess. Sometimes it was not real scientific inquiry, not at least in our adult way. The children were doing their experiments in their own way, searching for their own science which may not coincide with our adult comprehension (Piaget, 1969). In any case, the active science sessions are not intended to produce PhD graduates from children. On the other hand, especially with teenagers and especially in Ruhengeri, the participants definitely expected to learn something from the sessions and they wanted to be taken seriously. The scientific content of the sessions, though, while sometimes altered by the participants, must be real and clear in the minds of the adults from the beginning.

During the course of the sessions, it was sometimes necessary to manipulate the activities to allow some children to reach a concrete result faster than would have otherwise been the case. In this respect, the educator has to interfere and drift away from a genuine constructivist approach (Perrier & Nsengiyumva, 2003). It is in fact important that the children do not get stuck for too long, that they all enjoy the activity irrespective of their actual capacity, and that they experience a positive outcome, particularly in relation to their self-esteem. It is important also to appreciate talents when they are present, and to avoid levelling off. It is not desirable, though, to manipulate the ZS, as children dislike unfair games.

Active Science and Therapy: Discussion and Theoretical Issues

Evaluating the effectiveness of psychotherapy is in general a difficult problem (e.g., Kazdin, 1991), and a matter of lasting debate, which actually depends on what is meant by therapy. Discussing therapy also requires a theoretical model of trauma (e.g., Varvin, 1998), which is also a complex, poorly known, and sensitive matter (Summerfield, 1999). Given the stage of the research being reported in this paper, no quantitative assessment concerning active science as a clinical tool can be proposed here. However, our sessions did lead to definite happenings with the participants, some of them not anticipated, which do raise a number of interesting issues. These happenings correspond to evolutions of attitude or expression or, in a broader sense, to signatures of changes of states of the being (Perrier & Nsengiyumva, 2003). Some examples are listed in Table 2. More than two items were found in about 75% of the participants in Rwanda and about 95% in Nepal. Usually, once a first change had occurred, a cascade of other changes followed. Some changes could be conserved from session to session but also, sometimes, regression was observed. Such chain reactions, accelerations, oscillations, turning-points, and other aspects of non-linear dynamics (van Geert, 1998) are recurrent features of resilience (Monaghan-Blout, 1996; Rutter, 1999) and post-traumatic growth processes (Caloun & Tedeschi, 1998).

Table 2
Examples of Attitude Shifts Observed During the Active Science Sessions

Down (negative) state	Up (positive) state
Afraid to ask question	Asking questions
Annoyed by the presence of others	Enjoying the presence of others
Does not want to work with others	Happy to do something together with others
Not being able to play	Being able to play
Repetitive play	Creative play
Not interested in the outside world	Curious about the outside world
Not interested in showing things to adults	Eager to show things to adults
Does not want to answer personal questions	Able to talk about origin and past
Does not react to jokes	Finds the jokes funny
Does not laugh or smile	Can smile and laugh
Thinks he/she cannot achieve anything good	Thinks he/she can do something
Hiding when asking for volunteers	Volunteering eagerly

Active Science Sessions as a Mediation

As pointed out above, active science sessions open opportunities (Barton, 1998), opportunities to leave the sometimes dreaded environment, where one remains locked up in negative experiences, opportunities to develop relationships, to restore the social value of the person, to get involved, and to transmit messages such as complaints about the rules of the institution, the management, the caretakers, or peers.

Some topics of the sessions were particularly significant in relaying information about the children, or from the children to the adults. The fascination with food is conspicuous for refugees who have experienced hunger, and remain haunted by the fear of hunger (Barton, 1998). In Nepal, after they constructed a solar oven, the children were excited cooking marshmallows (presented as "chicken"), absorbed in their world, and forgetting the adults and the time. Manipulating food, playing with food, and being allowed to waste it, stirred heavily in the children. Moments of the sessions, like the use of sharp tools, also awoke buried feelings and the problems of dealing with threat. Such moments have to be identified, so that opportunities of verbalization can follow if needed.

The Objects of the Active Science Sessions

Active science supports the construction of thoughts from experiments, and requires the use of various objects. Manual activities, like modelling clay or drawing, are often used in clinical settings such as in squiggle (Winnicott, 1971). (Squiggles are drawings that the child and the therapist scribble together and exchange.) During our active science sessions, using objects and tools certainly caused much excitement but, more importantly, touching, breaking, repairing, showing, and performing the experiments for me and others triggered first speech and attitude shifts (Table 2).

Further impacts of the objects were observed. The most spectacular in Rwanda was the effect of the large bamboo Platonic solids, displayed in the courtyard of the Ruhengeri UACC, arranged like an open museum. Not only did these solids become the meeting point before the sessions, but most

children and staff of the centre gathered around them, asking questions, talking seriously, or just joking nonsense. The aesthetic and mysterious value of the objects was probably perceived more readily than their mathematical value, but it was always possible to go back to the number of faces, of sides, and the number and multiplicity of vortices, triggering always joyful answers. Possibly, such geometrical forms play an important role in the structuring of space, as a symbolic representation of the organisation of an inner space as in the Pankow spirit (Pedinielli, 1994). Maybe the Platonic Solids, moulded from their own hands, represented the recreation of some order, the possibility to see and reproduce a structured natural world, and thus represented a strategy to control anxiety. The importance of this fact cannot be understated in circumstances of prevailing chaos, where every day the children had to make sense of incomprehensible events and memories. Clearly, beyond the active science sessions themselves, these big objects had created an event, and a cross-cultural mediation.

Similarly in Nepal, we noticed that the children liked to take away the small objects used during the sessions, whether to continue the sessions later on, to use them in a totally different spirit such as a toy, or simply to be little personal things to keep in the pocket. Once observed, this fact was encouraged in following sessions, by multiplying miniature components, and it was observed that some children were happy to take things, whereas others did not use this opportunity at all. The meaning given by the children to these objects was probably outside the scope of the active sessions themselves, but more important to them than the plain tools of the experiments. These objects are associated with two layers of meaning: at one level, as part of a common scientific discourse, and at a second level, as part of a more personal, less clearly identified, representation. This duality must play an important role in the therapeutic process. These objects, by participating in the building of a new world, outside and inside, may have symbolic meanings compatible with fulfilment and conceptualisation of trauma, as hypothesised in some psychoanalytical models (Varvin, 1998).

The Words Used During the Active Science Sessions

Although the impact of objects suggests that much of the attitude shifts observed during the session proceeds without verbalisation at all, the role of the words cannot be ignored. The importance of language in expressing scientific ideas has been discussed in detail, both in the context of Piagetian developmental theories (Martin, 1999) and within sociocultural and historical frameworks (Ivic, 1994; Vygotsky, 1934). Active science sessions first rely on the construction and analysis of experiments, but words remain the primary support of exchange of information between the children and the adults, and among the children. Albeit part of a well-defined investigation, words always carry their loads of meaning. An interesting process to watch is the appropriation of scientific jargon. Some children also display abilities in altering the meaning of scientific words, producing jokes. This suggests that a significant quantitative measure might be constructed from sound recordings of the sessions. Such recordings could also elucidate the role of the inner speech, which could be an expression of the Piagetian original autism and egocentrism, or a first step towards Vygotskian social participation.

The emotional aspect of questioning was investigated in Rwanda (Perrier & Nsengiyumva, 2003) but only the surface of the matter has been tackled so far. Despite inspiring pioneering debates (Vygotsky, 1934), the knowledge about the use of language in science remains sparse. The therapeutic aspect of science education could benefit, in particular, from a careful evaluation of the theoretical developments associated with Lacanian psychoanalysis.

Active Science and the Ego

PTSD includes loss of self-esteem (Berger, 1996; Bettelheim, 1943; Yule, 2001). This was definitely observed in Ruhengeri, associated with post-genocide survival guilt, but also in Nepal, associated with a feeling of failure of being able to sustain relatives. This loss of self-esteem leads to depressive states (mostly bipolar depression) and affects possibilities of resilience (Rutter, 1987). Attitude shifts observed during the sessions (Table 2) suggest that some level of restoration of self-esteem did occur, which can be considered as a first step in a therapeutic approach (Rutter, 1999).

Pathological conditions may also result from overproduction of the ego (Grünbaum, 1997), which can be part of a survival strategy. Active science requires confrontation with others and confrontation with experiments and reality, which includes the lesson of not being necessarily right. Thus it is not surprising that some participants in our sessions behave less arrogantly after the sessions. However, the role of the educator at that stage is crucial. Unless humbling experiences are interpreted positively, loss of self-esteem may be exacerbated.

Active Science and the Psychic Sanctuary

Independently of the way the ego is handled and expressed, some other mental survival strategies can have a detrimental effect on the contact with reality, including past and present objects (Grünbaum, 1997) and, in the long run, especially in children, compromise the possibility of recovery from trauma and loss. One of these strategies, referred to as the psychic retreat or psychic sanctuary (Grünbaum, 1997), is characterised by defensive withdrawal into an inner area of peace and protection, including less communication with others and with the real world as well. This hypothesis explains a number of symptoms, such as compulsive repetitive play and semi-autistic behaviours. It might also explain the observation that patients with PTSD tend to have elevated awakening threshold (Dagan, Lavie, & Bleich, 1991), sleep being one possible expression of this sanctuary.

Active science sessions may have an interesting ability to contain this psychic sanctuary, or may propose a new psychic sanctuary, which can potentially lead to resilience instead of stagnation. Indeed, this may be the meaning of the small objects taken after the sessions, carefully kept in pockets or secret locations. In this way, the post-traumatic self-created psychic sanctuary is replaced progressively, session after session, by a new one, where symbols of trauma and loss are replaced by experiences of the world and memories of joy.

The success of the telescope in Nepal can be interpreted in this light. Indeed, Jupiter and Saturn, after becoming living and real objects having their changes and moods day after day, became remote friends, friends that will not disappoint, projected far away from the dismaying surrounding, friends to dream about, friends to travel with to other lands. More than a simple activity, the telescope here becomes the support of a resilience strategy, a strategy similar to the imaginary presence of comforting virtual friends, secretly met in the evening by some children. The process here is to replace the pathological investment of heroes, fairies, or self-built spirits, gathered in the transitional area, by real and sound substitutes, deeply rooted in the real world, real life, and, hopefully, at the end, real parents and real friends. The group activity therefore surprisingly leads to important processes taking place at the individual level.

Active Science and Affective Investments

Clearly, beyond the science activities themselves and their particular features, the main factor that can lead to attitude shift is whether the participants are happy to come to the sessions, are enjoying their time, and are waiting eagerly for the next session. This affective involvement in the sessions is indicated by the expression of joy of the participants. In Nepal, the shelter home provides an island of happiness, as the children describe themselves. In contrast, in Rwanda the orphanage provided a limited safety only, with the staff also feeling insecure in a context of prevalent depression (Bolton, Neugebauer, & Ndogoni, 2002). The children were always anxious of Interhamwe raids at night and, even more, of forced reunification. The level of joy expressed during the session was therefore particularly conspicuous. This suggests that the sessions have to be emphasised as holding environments (Rogers, 1957) where joy and life are recreated (Varvin, 1998). Activities such as caring for butterfly pupae or germinating seeds typically support this affective demand (Berk, 1998).

In this light, it is important to emphasize here the importance of sticking to the announced schedule of the sessions, despite the difficulties. Such difficulties were not minor in Rwanda, where more than seven military check-posts had to be crossed every week to reach Ruhengeri. In Nepal, strikes, rallies, blockades, and curfews are part of daily life. However, such problems do not concern the educators only and it is important to demonstrate to the children that the situation can be dealt with by adults, and to prove unfailing dedication towards the children (Barton, 1998). A trusting relationship must be established before affective investments can take place. Furthermore, predictability, regular timings, and institutional rules have been clearly pointed out to be part of a therapeutic process for refugee children (Winnicott, 1970).

Affective factors do, though, drag the associated phenomena of transference and counter-transference described by psychoanalysis (Kinzie & Boehnlein, 1993). Active science sessions, in contrast to other approaches, offer an original way to deal with these difficulties (Mannoni, 1967). Indeed, child-centred therapies, such as regular clinical interviews, can result in the patient feeling locked in his pathological attitudes and, more generally, in a Lacanian sense, in various demands (desires that cannot be met) towards the therapist. Consequently, it has been noted that the suffering children, and in particular the psychotic children (Mannoni, 1967), need the therapist to lead their desires toward something that is not the adult, thus breaking the vicious circle. This process seems possible during active science sessions, where multiple attachments are possible--attachments towards objects, peer participants, and the managers of the sessions. Therefore, although active science sessions do not claim at this stage to be an authentic psychoanalytical therapy, they may nurture, in a particularly efficient manner, inner processes that seem amazingly similar to what psychoanalysts have been describing.

Active Science and the Unconscious

From these interpretations emerges a promising picture for a therapeutic perspective. Indeed, the meanings of the objects, the words, and the processes associated with the various attitude changes suggest that the practice of active science is associated with unconscious mechanisms that are expressed through un-phrased and un-phraseable behavioural patterns. In this respect, by the conceptualisation of unconscious structures and an associated resolution of conflicts, the active science sessions can be considered a genuine therapy.

For this point to be clarified, it is the whole nature of the scientific investigation, whether in the library, in the classroom, or in a research laboratory, that needs to be examined in a new light. Experimental science, in general, is able to develop unconscious cognitive processes, during which correct steps are taken without necessarily an associated rigorous framework. This hypothesis can be proposed, for example, as the mechanism underlying serendipitous discoveries such as the discovery of penicillin by Fleming or of radioactivity by Becquerel. Generally, it may be part of the daily experience of science or medicine. Such unconscious cognitive processes, possibly linked to procedural memory, should contribute to a positive and resilient reconstruction of the self, through an interactive experience of the real world.

Conclusions, Practical Recommendations, and Outlook

In this paper, active science sessions attempted in Rwanda and Nepal have been described and their therapeutic aspects have been analysed qualitatively. Although this work remains incomplete and lacks a quantitative methodology thus far, our observations lead to practical recommendations and raise theoretical issues.

When considered in a clinical perspective, active science sessions should focus on attractive topics such as dinosaurs, insects, or observation of the giant planets, although the scientific content may remain superficial at the conceptual level. Activities are supported by the scaffolding of a detailed preparation and appropriate intervention as described earlier, but should remain flexible and innovative, noisy and joyful, without the constraints of school. The objects of the investigations have to be selected carefully, including sometimes real instruments such as telescopes and microscopes. The objects of the activities play an important role in the construction of the therapeutic framework, both in the construction of a common visual new landscape, through large models, or in the construction of a personal psychic sanctuary, through take-away small objects. The setting of the sessions has to be designed in much the same way objects are gathered in a therapist's office, apparently randomly, but always with potential intentions, much in the spirit of the Winnicott squiggle environment (Winnicott, 1971). This work also indicates that groups should preferably include 5 to 7 participants, with a frequency of two sessions per week. An ideal session should include 45 minutes of common work with the participants, followed by one half to 1 hour of open-ended time. Finally, although the activities take place in groups, the achievement of the group as an entity is not necessarily the priority, and the role of the educator is to identify and actively guide genuine processes at the individual level.

The therapeutic potential of active science sessions is not only underlined by some observations collected during the sessions, but because these observations, revealing the evolution of attitude, suggest the presence of deeper and cross-cultural mechanisms that are at the core of any clinical process: restoration of self-esteem, opening up of opportunities, expression of the symptoms with or without verbalisation of trauma, containment, and re-structuring of a psychic sanctuary. The expression and sharing of joy, and the reactivation of curiosity, seem to be the keystone of a recovery process.

While preliminary, this analysis suggests that active science should be attempted with child refugees on a larger scale, including both scientists and therapists. Theoretical issues should be studied in detail and quantitative experiments should be designed, with a careful monitoring scheme and independent evaluation. In this investigation, it is not only the meaning of active science that is at stake, but the fundamental basis of the conscious and unconscious relationship between the individual and the external world. The meaning of science certainly is part of the

picture, but a better understanding of traumatic and therapeutic processes in general (Silove, 1999) would be desirable, especially in the case of traumatised children. In particular, operational models of resilience are needed (Rutter, 1987; Rutter, 1999). Resilience includes the capacity of achievement in a hostile environment, but does not seem well-correlated to protective factors (Monaghan-Blout, 1996), or more generally to genetic and environmental factors (Rutter, 1999). The succession of events after the occurrence of trauma, including the role of multiple attachments and the possibility to receive and give love, remains to be understood. How active science can promote resilience therefore appears as the next open question. The role of play in the ZPD would also require dedicated attention in a clinical perspective, but would also benefit an educational perspective as well.

Active science could definitely be part of an intervention with child soldiers (Bracken, Giller, & Ssekiwanuka, 1996). Although they look like children, they have many mature adult experiences of life (Pearn, 2003). Street children also share this particularity (Williams, 1993), and the sessions performed in Nepal indicate that the approach remains adequate in such cases. Active science could also be interesting in regular therapeutic settings, such as paediatric wards.

To conclude, one may add that, in the case of child refugees and child victims of violence and war, the theoretical and supposedly professional considerations probably are less important than simple and spontaneous compassion. The children of Rwanda and Nepal are not objects of investigations and willing, or unwilling, participants in a scientific experiment. They are, first of all, children--suffering children in need of simple attention and affection, and who are not necessarily eager for much more. In this respect, if the children were happy to participate in the active science sessions, just as they would be with any other type of activity dedicated to them alone, then perhaps nothing more should be expected. Their laughs and their smiles are their main message, and this may not need further elaboration.

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