

The Montessorian Garden of Pierino in Florence

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translation by Ann Ross

The Montessori Method and the schools where it is applied are well-known worldwide. However, Maria Montessori never actually declared herself to be a pedagogist but rather considered her research to be that of studying 'children in conditions of free choice'. Her degrees in biology and philosophy, along with her medical degree with a specialization in neuropsychiatry, clearly indicate this aim. She pursued this aim throughout her life. How did she go about achieving it?

She was a researcher in biology who laid the foundations for a Neuroscientific Theory which regarded not only the present could also predict the future workings of the mind. It all started with an idea for a 'naturalistic' laboratory created for the study of activities autonomously chosen by the child. This research activity originated from the study of "biological play" (Bekoff, 1972; Burghardt, 2001), i.e., those play activities (self-rewarding) that allow each species, during ontogenesis, to undertake its own 'psychogenetic' path (the path of the genesis of psychic structures dedicated to knowledge). According to Maria Montessori, observation should start with very young children placed in conditions of free choice, extending the investigation to any culture, ethnicity, religion, and socio-economic condition.

"The opportunity to observe the unfolding of the child's psychic life as natural phenomena and experimental reactions transforms the school itself into action, into a kind of scientific laboratory for the psychogenetic study of man. It - perhaps in the near future - will be, *par excellence*, the experimental field of psychologists" (Montessori, 1916). "It is strange to think that among the many naturalistic laboratories, only that of experimental psychology believed it could do without careful preparation of the environment" (Montessori, 1916).

The first naturalistic laboratory, following Maria Montessori's indications, was established in Florence in 1986 by the GRUF Association - University Research Group of Florence. It employed the Montessori Method and ethology for the description of observational data (Honegger Fresco, 1989). The laboratory was later named "Pierino's Garden" in collaboration with the Institute of Neuroscience in Florence in 1996 (Pecori, 1988; 1989; 1994; 1996).

Our contribution, as researchers in psychobiology of the GRUF APS Association in Florence, now a third-sector governmental organization, is to have identified, in the Montessorian Pierino's Garden, a model of a 'naturalistic laboratory' for scientific research on *H. sapiens*. Here, the natural development of species-specific mechanisms described by Maria Montessori is measurable. In other words, we built an experimental psychology laboratory for autopoietic (self-building) (Maturana and Varela, 1992) and psychogenetic (Ricci Barbini, 2018) child study.

Description of the B.E.L.L. Laboratory

We named this laboratory in Florence B.E.L.L. – (Bambini Etologia Laboratori Longitudinali) Longitudinal Laboratories in Child Ethology. It spread abroad thanks to the eponymous Comenius B.E.L.L. adult training project, funded in Europe in 2006 with the project of the same name.

This project led to the standardization of the Montessorian Garden of Pierino in Florence by setting up an identical laboratory in Fagaras, Romania, called Veverita Roz (Pink Squirrel). Both laboratories produced similar results despite substantial differences in the socio-cultural background of the children as those in Fagaras were on social assistance unlike those in Florence. The Laboratory was duplicated in three months, and adult training took three years, as described in the Training Dossier (Pecori et al., 2010). The development of Pierino's Garden, along with the B.E.L.L. Veverita Roz laboratory in Fagaras (Romania), through the study of the same effects on children, sparked the idea of setting up an international educational and scientific network that was implemented with the European Showcase in-service Comenius Training courses from 2010 to 2015.

To begin with, we shall describe the architectural and ergonomic characteristics of the B.E.L.L. Laboratories. These laboratories of 40-60 square meters, are appropriately equipped with sets of activities responding to biological play that must always and in all cases be 'chosen by the child.' The B.E.L.L. laboratories are monitored by closed-circuit cameras, which, from a scientific point of view, unlike schools, allow reliable, objective, and continuous systematic biomechanical (Pecori, 1989) and acoustic (Ricci Barbini, 2011) recordings with longitudinal samplings. The environment is organized like a small house where all activities are possible and manageable by the child independently. These are real activities, not simulated, responding to spontaneous and non-induced primary needs. It is free choice that guides the child, and only in this way can a self-constructive and self-regulated work rhythm emerge (Montessori, 1952).

In these laboratories, the testing of biological play sets is particularly important, as well as the maieutic communication from adults to children. Important too are the use of collective games to achieve the 'normalization' of focused attention and body control, positive connotation training as reinforcement, the elimination of sources of anxiety, and external control of discipline.

*Multidisciplinary use of the B.E.L.L. Laboratories
In the field of health*

The prevention of disorders that compromise an individual's mental health begins at birth or perhaps even earlier.

In this article (Pecori, 2013), we place importance on respecting the child's self-regulation rhythms during its constructive process because nature does not build randomly. Prevention results from respecting the autopoietic system of the organism, trusting the "law of growth" that guides it. Prevention is about helping adults reduce the stress inherent in caring for offspring, which often brings about inadequate caregiving during the early stages of infancy and later. Prevention entails organizing educational training, and research services aimed at protecting the child's self-regulating growth processes as well as helping to train the caregiver to respect these principles.

The afore-mentioned article also makes reference to multiprofessional diagnostic assessment, of which the longitudinal and quantitative detection of treatment confirms the validity of this approach at preventing personality disorders.

The use of multidisciplinary diagnostic assessment of the child and its family in the B.E.L.L. Laboratories, now forms part of the International Adult Education Network. These laboratories with their use of scientific measurement, have become the subject of other projects, both European and national as we shall discuss later.

On the 'normalization,' described by Maria Montessori, of focused attention function, GRUF conducted a systematic study in 1996, (Pecori and Gomez Ramirez, 2001) [<https://icmontagnolagramsci.edu.it/sito-download-file/129/all>].

This scientific application conducted on a case of ADHD, in which spontaneous self-healing occurred, promoted similar studies on other childhood disorders, both in Florence and Romania, such as cases of autism, psychopathy, depression, Asperger's, secure attachment difficulties, conduct disorders, and so on (unpublished studies). The research work of the B.E.L.L. Laboratories has produced a substantial database over the years thanks to the use of technology and ethology.

Uses in the scientific field: "Toward a Biological Theory of the Comparative Autopoietic Development in the Young of Different Species".

As we have seen, the scope of scientific research at the B.E.L.L. Laboratories is fundamentally multidisciplinary, involving primarily the psychological, biological and medical fields. Maria Montessori had already identified some natural mechanisms of child development that could be studied scientifically. These have since been expanded by later discoveries. Examples are biological play, sensitive periods, attachment relationships, biological rhythms (activity/rest), cycles, selective attention, motor coordination, self-correction of moral errors or self-discipline, spontaneous imitation, choice determination, error control, and so on. These are just some of the developmental mechanisms that can be scientifically studied in our B.E.L.L. laboratories. In fact, scientific research on this topic is rather limited precisely because of the difficulty of studying such mechanisms in a controlled environment. This is especially true for *Homo sapiens*, as it is characterized by a long developmental period and is therefore difficult to study over a lifetime.

More and more studies, including comparative studies in mammals, highlight the fact that the preservation of such developmental mechanisms underlies the physical and mental health of infants and future adults (e.g., Lillard and Quest, 2006) and therefore, in-depth studies of the ontogenetic process of the young are fundamental. Longitudinal measurement of the infant's behavioral patterns by closed-circuit video at B.E.L.L. Laboratories, and subsequent ethological investigation, enable verification of the scientific validity of the autopoiesis hypothesis underlying the healthy development of the young of our species. This hypothesis lies within the framework of Maturana and Varela's Theory of Self-Construction through Self-Regulation (Varela, 1979; Maturana and Varela, 1992). Self-regulation can be defined as that process, probably peculiar to all living beings, which would allow the individual to self-correct, that is, to modify his or her behavior, through feedback mechanisms, depending on the effects obtained, which may represent "reinforcements" but also "punishments" for the individual (Mingers, 1997; Scapini and Campan, 2004). The process of self-regulation, peculiar to the growing individual, would come into being when its biological rhythms and needs are respected, that is, under conditions of free choice; if these conditions disappear, self-regulation does not appear to manifest itself (Klesges et al., 1983; Birch et al., 1998). "It is necessary to adopt a scientific point of view in order to interpret the facts that manifest themselves in children... it is necessary to observe, more or less like a naturalist, the unfolding of certain phenomena of life" (Montessori, 1916). Thus, it is essential to have a "prepared environment" in which to observe the natural mechanisms of development: through the ethological observation of the child (quantitative and systematic, under conditions of non-interference). Maria Montessori developed "a specially prepared environment in which the child assimilates whatever culture is disseminated by the environment, without the need for teaching" (Montessori, 1952).

One of the most important characteristic phenomena of development is biological play, defined by Maria Montessori as a spontaneous activity guided by ontogenetic processes, which manifests itself in the individual "with an intense interest in certain actions repeated for a long time without any apparent benefit, until from these repeated actions suddenly a new function is explosively revealed" (Montessori, 1952). It was not until 1970 that biological play was observed and

recognized in all mammalian infants and other species, with its peculiar characteristics and fundamental biological function for learning most species-specific skills (Bekoff, 1972; Burghardt, 2001). It occurs during specific windows of time, called sensitive periods (Hinde, 1962; Bateson, 1979; Klaus and Kennell, 1982a), during which neural activity derived from experience can effectively modify maturing synaptic circuits (summarized in Katz and Shatz, 1996). The play behavior of the young, which is self-rewarding, has clearly identifiable features (Burghardt, 2001), most notably the repetition of an activity over a period of time that generally coincides with the sensitive period that ends with the acquisition of the skill itself. All these processes are supported by the selective synaptic stabilization that occurs during the development of the nervous system (Changeux et al., 1974). In ethology, a sensitive period is defined as a genetically determined developmental period during which organisms are particularly susceptible to certain environmental influences. Once this period has passed, the threshold of receptivity to a given stimulus that elicits a specific response is raised (Lorenz, 1935; Campan and Scapini 2004). However, learning specific skills can also occur when the sensitive period is closed, but with greater difficulty. (Hinde, 1962; Bateson, 1979; Klaus and Kennell, 1982a; Katz and Shatz, 1996). Significant in this regard are the famous cases of "wild children," who had been deprived of species-specific linguistic and social experience in the sensitive period and were no longer able to learn human language correctly (Curtiss, 1977).

In the B.E.L.L. Laboratories, the presence/absence of biological play, its behavioral and temporal characteristics through which it is realized, including rhythmic patterns, can be scientifically studied. Indeed, the emergence of biological rhythms underlies the development of the young of all species, and the observance of such rhythmicity (activity/rest rhythms), as well as for other biological functions (e.g. sleep/wake rhythms, feeding rhythms), seems to be fundamental for healthy development. Studies in adult humans have shown that adherence to biological rhythms underlies our mental and physical health with clear epigenetic effects (Markwald et al., 2013; Eckel-Mahan et al., 2013; Asher et al., 2010). During development, certain rhythms associated with a particular stage of development emerge independently of external stimuli: when the effector organ is ready, the rhythm occurs.

This occurs at all levels of behavior: examples include the development of motor activity (Thelen, 1979), language, play, and the still partially unstudied sleep-wake rhythm and feeding (summarized in Löhr and Siegmund, 1999).

Another important developmental phenomenon that can be detected and studied in the B.E.L.L. Laboratories is the attachment relationship between the child and caregivers. Bowlby devoted himself to understanding the attachment process, primarily in humans, but formulated the "Theory of Attachment" (1969-1980), inspired by ethological studies of other animals (Lorenz, 1935). In a comparative approach, attachment is defined as the specific relational bond that is established between the infant and the caregiver. That is, in a period of particular sensitivity, the neonatal phase, the infant "absorbs" the attachment model in relation to the caregiver to obtain competences regarding survival and reproduction. Thus, the attachment relationship is fundamental in laying the foundation for the development of the whole personality. Several studies emphasize that the caregiving behavior of parents or substitute caregivers appears to be an essential condition for the development of self-regulation skills: caregivers would initially act as external regulators of the child's rhythms and later influence the child's gradual ability to self-regulate (Grossmann and Grossmann, 1991; Spangler et al., 1994; Hofer, 1995). This would occur not only at the level of a psychophysiological dimension (Gunnar and Donzella, 2002), but also in the cognitive and behavioral domains (Bernier et al., 2010). In other words, as Montessori (1916; 1952) had already conceptualized through her observations, if the caregiver is able to interpret and respond appropriately to the child's biological needs, that is, to respect the child's rhythms, he or she may be able to provide "autonomy support" and thus enable the emergence of self-regulatory processes (Bowlby, 1969, Landry et al., 2000; Bernier et al., 2010). On the other hand, when responsiveness is absent or ambivalent, autonomy is not established, and consequently, neither is the capacity for self-regulation. This seems to be linked to the involvement of the stress response system (hypothalamic-pituitary-adrenal axis), which is intensely activated (Gunnar et al., 2006), creating a sort of continuous "state of alert" in the organism, which prevents the child, as well as other mammalian infants, from engaging in biological play. For all mammals, including humans, the long-term repercussions involve the entire system of the organism. We are talking about more or less serious behavioral,

emotional and physiological alterations, including the increase in anxiety in stressful situations, the rapid slowdown of development, the absence of vocal threat and therefore the increase in physical aggression, the reduced learning ability, the appearance of respiratory disorders similar to asthma and gastrointestinal disorders.

In more severe cases, infant mortality also occurs (rodents: e.g., Levine, 1994; McCormick, 1998; Pryce et al., 2004; non-human primates: e.g., Ottenberg et al., 1958 - cats, Seitz, 1959 - humans: e.g., Spitz 1945, 1951; Bowlby, 1969; Duhrssen, 1960; Ainsworth, 1969). In addition to the aforementioned health effects, among the most common psychopathologies associated with attachment disorders in humans are depression, post-traumatic stress disorder, and personality disorders, including borderline syndrome (e.g., Heim and Nemeroff, 1999; Takeuchi et al., 2002; Henessy et al., 2010; Levy et al., 2011). There are also significant intergenerational effects through epigenetic modification that result from these consequences (Caldji et al., 1998; Youngson and Whitelaw 2008). These consequences are often underestimated in the child's growth process today. Therefore, in order to prevent distress, we believe an in-depth study of the attachment bond between the child and their reference figures is crucial. At the B.E.L.L. Laboratories, it is not only possible to study this scientifically but also to implement interventions using the Montessori method.

Self-regulation, therefore, seems to be at the core of healthy development in both animals and children when their biological growth needs and rhythms are respected in an autopoietic, self-constructive perspective. In B.E.L.L. Laboratories, self-regulation is measurable. Maria Montessori herself did not want the term "Montessori Method" to be used because we are dealing with "biological development, and you cannot call nature's way a method" (Montessori, 1952). She spoke of an "inner teacher" guiding the child's development. In classical ethology, this is defined as a "genetic predisposition to learn" (Eibl-Eibesfeldt, 1967). In conclusion, as evidence of the importance of the autopoietic process, an example of self-regulation related to eating behavior is provided. Both infants and preschoolers are capable of modifying their food intake in response to the energy content of the diet. However, if the choice is denied to them through food control, this capacity

seems to be blocked or reduced. Adult control over food, rather than reducing the risk of obesity or other eating disorders, appears to be one of the main non-genetic causes (Birch et al., 1998).

Like the aforementioned natural development mechanisms, many other phenomena can be the subject of scientific investigation at the B.E.L.L. Laboratories. Some of them, already identified by Montessori and only minimally studied, include the "law of maximum effort," concentration, movement slowness, sensitive periods (e.g., language, sensory, motor, logical), movement precision, spontaneous imitation, exercise repetition, error control, activity and rest rhythm, spontaneous feeding (Ricci Barbini, 2018), choice determination, the "help-me-do-it-myself" behavior, society for cohesion and its rules, the "happiness of existence," the appearance of "normalization" (Pecori and Gomez Ramirez, 2001), and ethical self-control.

*Use in the Adult Education field, including training to train:
an International Network*

The creation of the B.E.L.L. Laboratory in Florence's Giardino di Pierino - together with its Romanian twin Veverita Roz (Pink Squirrel) - has facilitated the spread of the idea of an international educational and scientific network. This network, using the B.E.L.L. Laboratories, goes beyond the school system by promoting studies on the developmental biology of our growing species or the autopoietic study of humans using the principles of Maria Montessori.

The B.E.L.L. Laboratories and Adult Education

It was the 2015 Erasmus+ European Project "A.U.T.O.P.O.I.E.S.I.S." - Autonomy and Training in an Organization for Childhood Mental Health Prevention by Optimizing Social Innovation, Experience, Study, Imagination, and Science - that pointed out the great need to establish an international network of professional health and educational services with access to B.E.L.L. Laboratories. As some studies have shown, the Montessori method would promote the self-regulated growth of the child, resulting in mental health benefits (e.g., Lillard and Quest,

2006). Indeed, the B.E.L.L. Laboratory aspires to create a scientific network for the study of the biology of child development, while enabling the dissemination of services aimed at protecting the psycho-physical well-being of future adults. This network is suitable for creating excellent educational services with the aim of: (i) preventing child and adult distress, (ii) supporting early distress/disabilities, and (iii) supporting interactive adults by reducing stress in family and during the work with children. The main and final recipients are children aged 2-6 years. It also involves childhood operators (various professionals, including doctors, psychologists, biologists, and educators), public and private organizations, as well as parents and relatives of children.

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