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Review Article

Psychomotor Development Supported by A Sensory-Motor Approach in Young Children with Down's Syndrome

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Introduction

Down's syndrome (DS) or trisomy 21 (T21) is the most common genetic disorder affecting children, and the most frequent cause of intellectual disability. It affects around one in every 691 births in the USA every year [1], and 1 in every 400 pregnancies in France. The phenotypes observed in people with DS and other trisomy syndromes are complex and variable [2].

Although all basic motor skills are acquired in the same order of development [3], children with DS have slower psychomotoret al.,ment than typically developing children [4]: Thus, crawling begins between 12.2 and 17.3 months (compared with 7 months in typical children), first steps between 15 and 74 months (compared with 12 months) and the onset of autonomous walking between 13 and 48 months (compared with 12 months) [5]. Thereafter, they may show alterations in their basic motor behavior, particularly in locomotion, running, jumping or manipulation [4,6,7].

Delayed consolidation of motor milestones was initially thought to be due to problems of ligament laxity, decreased muscle strength, hypotonia and loss of balance, but it was later determined that these were not its main cause [8]. In the early stages of development, children begin to explore and control their own bodies, and then perceive and understand the world around them [9]. Intellectual development and motor activity are intimately linked [10,11].

Faulty body awareness results in inadequate acquisition of the neuro-perceptual-motor stages required for overall development, such as segmental control, lateral dominance, and spatio-temporal organization [10]. Movement is the foundation of human physical and mental maturation, hence the importance of supporting psychomotor development (Martinez & Anton, 2017).

Sensory and perceptual particularities of children with Trisomy 21

Babies with Trisomy 21 differ very early from typical newborns in their processing of sensory information from the surrounding world, particularly in visual, haptic, proprioceptive, and vestibular modalities, as well as in their intermodal relationships [12]. This immaturity of specific sensory systems results in incomplete, truncated and possibly distorted sensorimotor experiences for these children. Visual (glaucoma, strabismus, refractive disorders) and auditory disorders are among the perceptual and sensory dysfunctions frequently found in people with T21 [13]. Their visual perception is often characterized by slow decoding with difficulties in structuring the peripheral visual field, resulting in discrimination on highly contrasting stimuli. As the haptic sense (of touch) via tactile-visual intermodal transfer is virtually absent in Down's syndrome children (between 12 and 17 months), they engage in less tactile exploration (in favor of visual fixations), which also influences tactile discrimination (of shapes, for example). Children with T21 compensate for the lack of tactile information by exploring objects by mouth. These sensory particularities have an impact on motor skills. While a healthy child, for example, develops

ground support from the decubitus position (lying down) through to the balancing phase, a child with Down's syndrome, with far fewer tactile sensory afferents, is forced not to use certain parts of the body (which are fundamental to future motor development), inevitably delaying motor acquisition, including sitting, crawling and walking, and thus adopting more inefficient motor organization [12].

The bodily experiences induced by sensory experiences are the first forms of difficulty in awakening to the discovery of the outside world. Encouraging sensory experiences, supported by the adult (therapist, parent, educator), represents support for the sensory-motor integration of children with Trisomy 21, in order to consolidate the foundation of their learning.

Particularities of body awareness in children with Trisomy 21

By combining visual, auditory, tactile, proprioceptive, and vestibular sensory particularities, children with Down's syndrome develop a fragile awareness of their bodies.

Perceptual integration is based on the perceptual-motor foundations required for coordination. The basic motor patterns developed by Le Metayer (1999) under the term "Niveaux d'Évolution Motrice" (Motor Evolution Levels), must be chained together into more complex events with an increasing chronology, testifying to a progression in the child's bodily ease during these motor experiences. This learning of body awareness involves not only taking into account body support and awareness of the body axis, but also the different parts of the body and their arrangement in situ, i.e., in relation to external elements of the environment.

Down's syndrome children, characterized by axial hypotonia and little use of vision, have poor proprioceptive sensitivity, which in turn influences their postural control [12]. As their vestibular system is immature, postural control cannot be efficient. Delayed locomotor and postural acquisition can be explained by the delay in neurological maturation, but also by other difficulties associated with the syndrome, such as valgum knee (inward bowing of the lower limbs), flat feet and plantar hypotonia, which can lead to tilting of the head backwards [12]. Children with Down's syndrome make little use of their visual and proprioceptive systems in the development of their body awareness, and their motor peculiarity results in a lack of anticipation in the analysis of their environment. This lack of visuo-vestibular calibration can be seen, for example, in the difficulty in achieving standing [13]. Interventions focusing on vestibular stimulation would benefit them, particularly through play exercises.

Contribution of sensory-motor stimuli

The aim would be to offer T21 children's sensory stimuli and encourage them to pay particular attention to the bodily changes induced by these stimuli.

The term "sensory-motor" was first used by Piaget in 1936 to describe the 1st "sensory-motor" stage, a period of development extending from birth to 18-24 months. "This sensory-motor period is characterized by the fact that the main materials that fuel psychic activity are sensory and motor in nature" [14]. Sensory-motricity is a concept that reflects the relationship between the organism (sensory modalities, body, and movements) and its environment (which provides stimuli). According to Williams and Shellenberger's pyramid [15], sensory-motor experiences arise from sensory explorations and give rise to motor learning.

Thanks to these stimuli, children with or without T21 will explore, understand, imagine, combine, express themselves, experiment, and thus develop by acquiring a certain mastery of their body in space [16]. These sensory-motor games frequently emphasize the motor aspect, calling for motor coordination and dissociation.

Children often integrate movement with music, especially at pre-school age [17]. Teachers design playful activities combining instrument manipulation, movement, and musical sounds to engage children's interest. Movement is an important means of expression used by humans to express their desires and feelings. Children with DS show a deficit in the perception of rhythm [18], with repercussions found in the acquisition of walking, the realization and fluidity of movement and balance. There is great potential for improving children's rhythm synchronization skills [19,20]. The authors found that music education provided from the age of 5 (or younger) improved skills in the executive functions of the motor control organs of the child with T21 [21].

At pre-school age, to support the development of fine motor skills, oculo-manual and bimanual coordination, sensory-motor stimuli are offered in the form of explorations (e.g., different materials) that lead to different sensations, different perceptions. The adult (parent, therapist, teacher) encourages and accompanies the child by verbalizing the child's sensations (pleasant, unpleasant, surprising, etc.), the description of the object (hard, soft, rough, wet, hot, cold, the smell, etc.), with the use of specific objects (the use of soft balls, soft balls, hard balls, pimpled balls, fur balls, foam balls, sticky balls, etc.).

As tactile sensibility is closely linked to food orality [22,23], orality disorders, may be present in children with T21 [24], and are often associated with food sensory and perceptual particularities [25]. If the child has an aversion to body contact and/or to touching all types of materials, including food, one of the first recommendations is to offer a body massage after the bath, thus helping to stimulate deep sensibility [26]. The child can also be encouraged to walk barefoot and explore non-food materials, leading later to the exploration of food [22]. In the case of specific oral disorders, Leblanc and Ruffier-Bourdet [22] have established a protocol aimed at progressive integration through tactile means; This involves starting with straightforward, non-food materials such as hard, dry objects (wooden and hard plastic toys), then touching dry, dispersible materials such as clay biles, then continuing with soft or sticky materials such as modeling clay, then introduce food materials such as cooked pasta, cooked rice and gnocchi, leading to the exploration of fluid, airy materials such as semolina, sand, feathers and cotton, which are particularly difficult for children with T21 to touch. At the same time, explorations began with bare hands, then the introduction of utensils such as cups of different

sizes enriched the game of exploration, moving towards decanting, exploring inside-outside, and later becoming part of more complex scenarios in pretend play (playing at preparing a meal). Exploratory play evolves to support fine motor skills, oculomotor and bimanual coordination, and vocabulary.

Through play, the child with T21, but also any child, moves from being a receptor to an active agent, with an understanding of the feedback from his or her movements, and thus contributes to the representation of his or her body in his or her environment. Once the child with DS is able to explore his or her immediate space through touch, sight and hearing, the integration of this sensory information in combination with the execution of motor skills will enable him or her to become aware of, and control, his or her own body [27]. Awareness of one's actions in the world becomes a driving force behind intentionality, which in turn regulates the body. Through solicitation and play, the T21 child becomes more involved in his motor skills, through the pleasure of movement. Play develops their skills and know-how, through space and time, and is a means of expressing their psychomotor potential.

Conclusion

Sensory-motricity, in both its sensory and motor exploration dimensions, is a fundamental prerequisite for body awareness, as it nurtures the feeling of existence in a child's body through the perception of its supports, its axis and the perception of its different body segments through different channels, essentially visual, tactile and proprioceptive. If all these channels are less perceptible in young children with Down's syndrome, this is why we need to make greater use of these mediations, so that these children can reappropriate these sensations and perceptions in a supportive environment. A sensory-motor approach that fully integrates the dimension of play can serve as an awakening to the body and give young children with Down's syndrome the feeling of regaining contact with themselves through their own exploration or through the intermediary of movement. By rediscovering his body, which he may not have had the opportunity to experience sufficiently, the young Down's syndrome child learns, through play, to be aware of it and to take possession of it in order to reorganize and rearrange it in such a way that his perception of his own body is conducive to more efficient motor skills. This sensory-motor approach to play can be a real tool for supporting development.

The relational component of play adds a real asset to the care provided, whether through sharing during sessions or the use of imitation in motor processes. People with DS have specific developmental trajectories in terms of language, motor skills and executive functions [7], which is why it is necessary to provide them with sensory-motor stimulation situations to support their development and prevent over-handicap.

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Conflict of Interest

No conflict of interest.

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