Understanding the autonomic nervous system in cerebral palsy

Better understanding of the interaction between perception, emotion, cognition, and the autonomic nervous system (ANS) has helped the identification of bodily signatures of mental activity. Signs of 'arousal' are often taken to reflect both attentional orienting and sympathetic reaction (for 'fight or flight'). This has fostered engineering efforts to use autonomic parameters, such as variation in heart rate or electrical conductance of the skin, as an interface with assistive devices (e.g. single-switch access technology for augmentative and alternative communication, mobility control, or other interactions with the environment). These developments are mostly at a prototypic stage but may soon help many individuals with the motor, speech, or intellectual impairments that commonly occur in cerebral palsy (CP). Meanwhile, to make these developments fully relevant, it is important to gain sound understanding of the ANS in CP.

The main ANS function is to regulate homeostasis under changing environmental conditions. This is carried out through a complex combination of reflex activities using feedback from the organs to adjust the physiological state of the body, and top-down control by central nervous system structures; this control is in turn modulated 'bottom-up' by afferent input. The result is a balance with varying emphases depending on the situation. The term ANS implies a single entity, but in fact refers to an aggregation of distinctive components producing different responses and showing differential involvement in physiological and pathophysiological states. The sympathetic system alone has several subcomponents (noradrenergic, cholinergic, and adrenergic), all distinct from the parasympathetic cholinergic system and the enteric nervous system.

The ANS is involved in virtually all body functions, ranging from cardiovascular, breathing, or feeding activities to urinary function and even bone remodelling. It regulates sweating and salivation; it modulates the perception of various types of pain; some of its health-protective effects are mediated by physical exercise. All these examples are highly relevant to CP.[1–4] The scarcity of studies of ANS in this condition is therefore very surprising.

A meta-analysis of heart rate variability in children with CP included only six studies, of moderate quality.[5] It found reduced variability and abnormal response to postural changes. The authors urged colleagues to conduct methodologically sound studies in the field – a call reiterated here.

What can be done – and how? The criterion standard for ANS research remains invasive microneurography at 'rest' and after stimulation maneuvers. On the other hand, non-invasive approaches, such as those used in the reviewed studies,[5] rely on routine recording and analysis techniques, and can be applied widely. They have, however, important drawbacks, insofar as they provide indirect reflection of ANS activity and do not allow clear distinction of which system has been tested. Heart rate fluctuations (technically RR variability) may provide a measure of parasympathetic influence, although other factors are at play. This measure is age-dependent, with unknown implications in CP. Another non-invasive approach measures the electrodermal activity, i.e. electric resistance of the skin as it varies with sweating, which is controlled by the sympathetic system. Unrelated physical and physiological factors also contribute to the electrodermal activity, possibly leading to unreliable or inconsistent results. Again, very little is known about this activity in individuals with CP. Pupillometry (the measurement of pupil diameter) also has potential relevance for ANS evaluation; so have minimally-invasive investigations of the bladder/sphincter or stomach contractility, and perhaps isotopic measurement of cardiac sympathetic innervation.

Data from such studies are necessary to discuss possible implications for clinical practice in terms of diagnosis, outcome, and management (also including applications for communication, etc.), and suggest how autonomic function should be further studied in CP. Much remains to be learned, and the field cries out for more well-grounded research.

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