Published in final edited form as:

Am J Intellect Dev Disabil. 2013 November ; 118(6): 413–415. doi:10.1352/1944-7558-118.6.413.

Biomarkers, Behavior, and Intellectual and Developmental Disabilities

Frank J. Symons and Jane Roberts

This Special Issue/Section on heart activity as a biomarker to advance our understanding of behavior in intellectual and developmental disabilities (I/DD) reflects perhaps a renewed or increased emphasis on integrative studies of behavior and biology in our field and others. In reality it also reflects editorial serendipity after noting several successive AJIDD submissions had included measures of heart activity as part of their respective study protocols. Subsequently, the contributing authors were approached and asked about considering their papers, after peer review, for a Special Issue/Section on biomarkers and behavior. We express our gratitude for their acceptance of the invitation and patience during the compilation process. We were also fortunate to have had two solicited commentaries from Steve Porges and Jim Bodfish providing their perspective on the approaches and contributions of the work described herein.

The relation between biology and behavior is complex and multifaceted; efforts to reduce one to the other can be difficult in the best case scenario and misguided in the worst, but the relevance of inquiry in one domain to understand the other is nothing new in our field's effort to improve our scientific understanding of I/DD. What is new is the relative ease with which biologically relevant information can be acquired from individuals even with the most significant impairments; we are living in the emerging era of revolutionary technology – for both hardware and software. Theoretical advances have also facilitated this work with recognition of the multiple etiological mechanisms for disorders including genetic, neurobiological, and environmental factors that operate in a transactional manner over time. The ways these technological and theoretical advances will lead to further progress in programs of I/DD research remains to be determined. Judging by the papers in the current special issue/section on cardiac biomarkers and behavior, there is feasibility being demonstrated and substantive progress being made (ranging from moment-to-moment real-time behavioral and biological recording to characterizing biomarker signatures at the group level in relation to function and outcomes). But, while there may be much promise in pursuing a biomarker oriented program of research, there is much that remains to be discovered not the least of which will be translational oriented studies designed to extend the discoveries to demonstrations that make a difference in the lives of individuals with I/DD.

The National Institute of Health (NIH) defined a biomarker as “a characteristic that is objectively measured and evaluated as an indicator of normal biologic processes, pathogenic processes, or pharmacologic responses to a therapeutic intervention”. In this AJIDD Special Issue/Section 5 papers have been assembled that shared one thing in common – all included a measure of cardiac activity. Why? Cardiac function, per se, while obviously essential for health and wellbeing is not the focus of inquiry. Examining electrical signals from the heart

muscle – which is neurally mediated centrally – can be regarded as a noninvasive approach into the central nervous system (CNS). Thus, more generally, the papers in this issue reflect a biomarker approach to studying aspects of physiology considered relevant to phenotypic features associated with many intellectual and developmental disabilities – severe behavior disorders and emotional regulation difficulties.

There are numerous reasons to incorporate biological processes in I/DD research. First, inclusion of a biomarker may help to identify underlying relevant physiological mechanisms in the absence of clear overt behavioral symptoms (masked, perhaps, because of motor impairments) or difficulty to detect via direct observational methods (i.e., ambiguous signals) in complex constructs (e.g., ‘anxiety’) as is reflected in a number of papers in this issue. Second, given the variability of language or cognitive impairment inherent in persons with I/DD, biomarkers can provide a measure of response that may not otherwise be available. A number of studies in this issue incorporate heart activity in samples of individuals who have severe behavior problems and moderate to severe intellectual disabilities precluding more traditional measures of self-report or informant-based reports that would have limited validity with these populations. Third, biomarkers can document biological vulnerability to later-emerging symptoms or disorders both within and across etiology-specific groups. In this issue, patterns of heart activity disassociated the emergence of autism versus anxiety and ADHD in fragile X syndrome in one study and were linked mechanistically with pragmatic language impairment in autism with differential associations in fragile X syndrome in another study. Fourth, biomarkers may reflect individual differences that could affect treatment response. Although there were no treatment studies in this issue, findings from the work described have clear implications for treatment such as reducing arousal to facilitate improved pragmatic language skills and reduced severity of self-injury or social-behavioral conditions. Finally, studies that incorporate biomarkers and environmental variables can examine the effects of multiple variables on outcomes and reduce over-reliance on main effects which can be overly simplistic or lead to false conclusions. In one study in this issue, an interaction of heart activity and age was evident suggesting that linear relationships cannot be assumed.

Although the general biomarker approach seems clear and somewhat compelling; there are myriad reasons for caution. Heart activity (the particular biomarker that is the focus of this issue) is a final common expression of multiple physiological processes reflecting numerous interacting biological activities including “CNS function, autonomic control mechanisms, metabolic activity, thoracic hemodynamics, cardiac chemo- and baro-receptors in addition to arousal and activity levels” (Oberlander & Saul, 2002, p. 428). Thus, there is some pause to consider what the cardiac signal reflects when it is measured in any one paradigm and for what purpose. But, as a neurally mediated marker, it has the advantage of being considered a linking parameter between physiological capacity and psychological function providing a means to investigate stress reactivity and clinical risk. Certainly there is a long history of doing so in developmental psychopathology oriented research and clinical investigation (Dennis, Buss, & Hastings, 2012). In that sense, the work represented in this special issue/section is translational as approaches from one domain of inquiry are being applied to another.

Moving forward, there are three issues (among many) that seem especially pertinent to our field comprised of vulnerable individuals for whom access to complex traits and states can be difficult because of cognitive, communicative, and motor impairment. The first is sliding into an ‘objectivity’ bias. The general concern is the possible bias that biology is ‘harder’ (more objective) than behavior (to use the terms very globally and loosely). The issue here is tied in with reductionism and reification, in part, such that complex constructs (e.g., emotion regulation) are reducible to a single biological parameter and then reified as such (e.g., high frequency heart rate spectra *is* emotion regulation). This may seem like a trite and naïve concern, but it is worth pointing out. The second is a ‘gee whiz’ effect (new technology and its applications) and the notion of “just because we can measure – name your favorite biological signature – should we”? We may need to guard against reflexively strapping on a cardiac monitor or swabbing saliva absent a compelling conceptual reason to do so. Not the least of which because it still takes time and effort to include the technology, despite the relative ease, and incorporate the findings in a meaningful way into behavioral measurement protocols. Last, our evaluative framework(s) are in their infancy. By this we mean; in relation to what are we evaluating the biomarker? We lack norms in a general sense within I/DD (age, gender, developmental) and with respect to different etiologically-based I/DD subgroups (e.g., syndromes), and very often appropriate controls are absent, lacking, or it is otherwise not clear what the ‘right’ control group should be for comparison purposes. None of the three issues are new; nor are they compelling reasons not to continue to develop biomarker approaches to enhance our knowledge and its application in I/DD. We mention them as points to consider while we try to leverage the promise and potential of biomarkers for understanding issues related to risk, screening, and mechanism in I/DD research.

References

- Dennis TA, Buss KA, Hastings PD. Physiological measures of emotion from a developmental perspective: State of the science. Monographs of the Society for Research in Child Development. 2012; 77(2) Serial No. 303.
- Oberlander, T.; Saul, JP. Methodological considerations for the use of heart rate variability as a measure of pain reactivity in vulnerable infants. In: Stevens, B.; Grunau, R., editors. Pain in vulnerable infants. Vol. 29. W. B. Saunders Co; Philadelphia, PA: 2002. p. 427-444. Clinics in Perinatology