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EXECUTIVE FUNCTIONS: A CRUCIAL BUT OVERLOOKED FACTOR FOR LIFELONG WELLBEING

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November 2021

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Photo: Sharron Bennett, NZ Listener

Acknowledgements

Wright Family FOUNDATION

Thank you to the Wright Family Foundation for supporting this work.

We thank national and international peer reviewers for their feedback.

EXECUTIVE FUNCTIONS: A CRUCIAL BUT OVERLOOKED FACTOR FOR LIFELONG WELLBEING

Key points:

- The skills of executive functions enable us to achieve basic tasks such as learning, solving problems, controlling our impulses and interacting harmoniously with others.
- Executive functions are underpinned by the development of specific brain pathways *in utero*, in infancy and in childhood.
- Impairments in components of executive functions place a person at greater risk of negative lifelong consequences, including school failure, poorer mental/physical health, job instability, antisocial behaviours and poorer quality of life.
- Impairments in executive functions impose a large societal burden and have intergenerational effects.
- Risk factors for compromised executive functions include low-socioeconomic status, poor maternal mood during pregnancy, parental insensitivity and neglect, toxic stress, high levels of non-educational screen time and unbalanced postnatal nutrition.
- Early intervention to assist all children to reach their full potential in executive functions is key to supporting their lifelong wellbeing.
- Confronting the challenges of compromised executive functions requires whole-of-government and whole-of-society thinking, as this issue cuts across multiple sectors.

What are executive functions?

Executive functions are the set of cognitive and emotional processes that enable us to work towards a goal. The skills that involve executive functions include planning and organisation, flexible thinking, focusing our attention, using information in our working memory, and being able to inhibit impulsive behaviours.[1] They are essential for learning and help with successful reasoning, problem solving and long-term planning. Executive functions therefore provide the most basic building blocks for meeting challenges across the life course and are highly predictive of success in social, emotional, behavioural and academic functions. Although the full capacities of executive functions are reached only in young adulthood, the foundations are laid during pregnancy and infancy through to the age of about six.[2]

Why are they important?

The many skills that involve executive functions help us to perform well, both individually and as a productive member of wider society, and the outcomes can have intergenerational effects (from parent to child). Executive functions are therefore fundamentally important to everyday life and wellbeing (Figure 1).

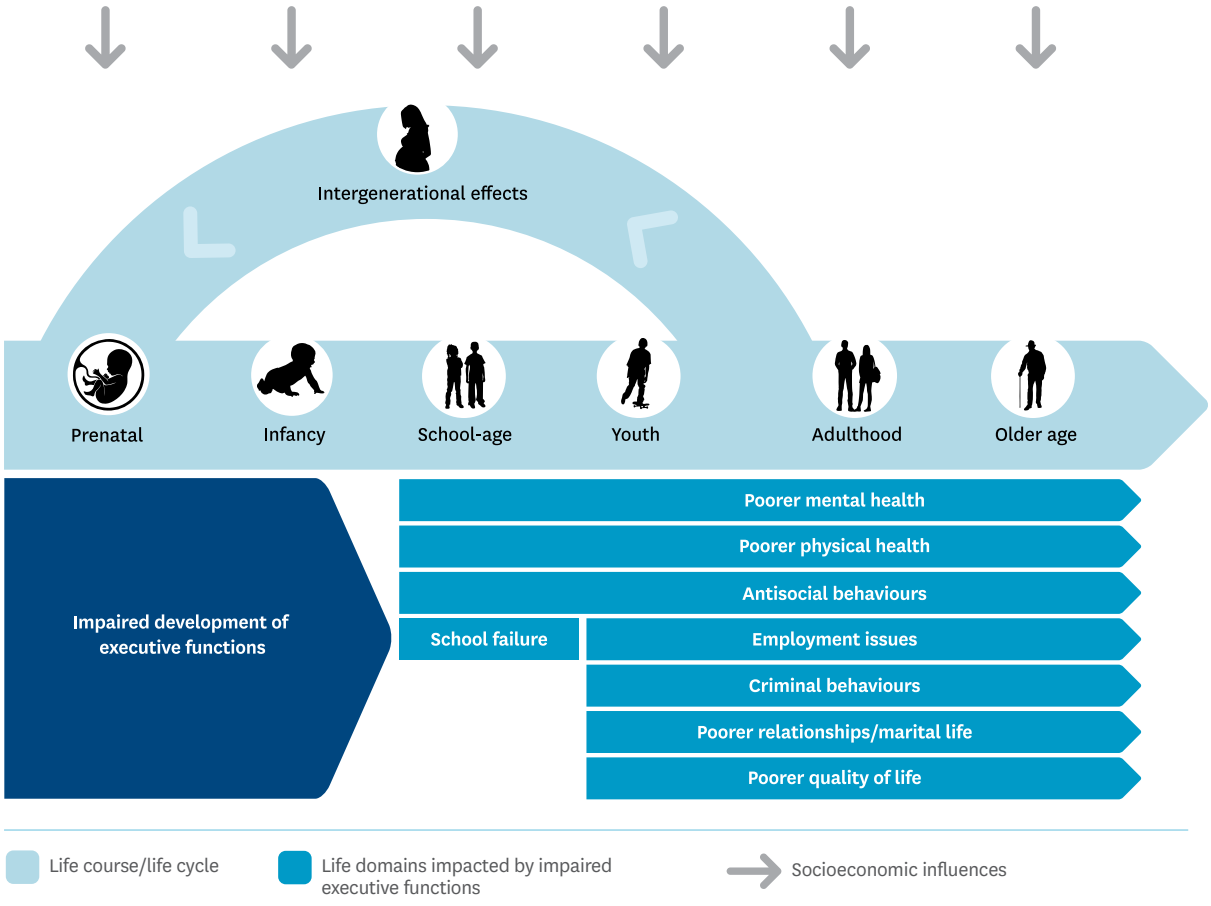

Figure 1: The lifelong consequences of impaired executive functions. Suboptimal development of executive functions, especially following conception and during the first few years of life, is a risk factor for impaired school readiness. This, in turn, increases the risk of school failure, employment issues and financial instability. Lower resilience has downstream effects on poor mental health, and impairment in social skills and impulsivity are risk factors for antisocial or criminal behaviours, poorer interpersonal relationships with others, and a poorer quality of life overall. The disadvantages may be passed on to subsequent generations in a vicious cycle via suboptimal parenting. Socioeconomic factors influence these outcomes through the life course. Although portrayed here as discrete domains for simplicity, the affected life domains are interrelated and underpinned by a common determinant: suboptimal executive functions.

School success – Effective executive functioning is indispensable for the ability to learn. It enables schoolchildren to be attentive, resist distractions, follow instructions, plan and organise activities and problem solve. Accordingly, executive *dysfunctions* will lead to greater risk of disruptive behaviours in childhood, learning disorders and, consequently, school failure.[3, 4] Not completing formal education has lifelong financial consequences associated with being less likely to find or hold down a job and having reduced earnings.

Youth wellbeing – The ability to control impulsivity and regulate one's emotions is critical to successful passage through adolescence. During adolescence, young people's authority figures shift from their caregivers to their peer group. At the same time, their incomplete brain maturation, particularly in the regions that govern self-control, leads to riskier behaviours.[5] In that context, executive dysfunctions will manifest as psychopathology, distress and excessive risk taking.[6] Compromised executive functions are linked to antisocial tendencies such as delinquency, aggression, and poor interpersonal relationships, all of which generally persist into adulthood.[7]

Executive functions promote psychological resilience and protect against the effects of stressful events that impact mental health.[8, 9] Poor mental health generally emerges during early adolescence, and New Zealand youth have been experiencing a rapid decline in mental wellbeing over the past decade.[10] There are many complex reasons underlying this trend, but this decline highlights the importance of optimal executive functions in mitigating the risks of developing poor mental health. Indeed, stress itself may disrupt the operation and development of executive functions, creating a vicious cycle.[11]

Success in adulthood – Poorer executive functions are associated with reduced productivity and the inability to hold down a job.[12] Employment difficulties may then worsen an individual's mental health challenges and reduce compliance with social norms.

Physical health may also be affected: there is a link between poorer executive functions and obesity throughout the life course, from childhood through to adolescence and adulthood, reflecting lower levels of self-control.[13] There is also strong evidence for higher rates of substance abuse and poorer adherence to treatment.

Having low childhood self-control or poor emotional regulation is associated with a greater likelihood of becoming a single parent and lower levels of skilled parenting, as characterised by reduced levels of thoughtful and consistent discipline, and warm, sensitive and stimulating interactions between parent and child.[14, 15] A lack of focused attention and responsiveness to a child's needs in turn affects the development of the child's own executive functions. The parent with impaired executive functions tends to have compromised mental health, which is in turn a core influence on all aspects of the child's neurodevelopment. This shows how the negative effects of impaired executive functions can be transferred across generations.

Mid/later-life wellbeing – The effects of executive dysfunctions extend well into later life. The Dunedin Multidisciplinary Study, a longitudinal birth cohort study tracking the development of New Zealand residents born in 1972–1973, has shown that children with poorer executive functions (as measured by poor self-control) grew up to display more biological, clinical, and neurological features typically associated with faster ageing at the age of 45.[16] In addition, poorer self-control in childhood correlated not only with being less prepared to handle health, social and financial demands in later life, but also with having lower life satisfaction.

Among older people, having better executive functions may help improve their mobility within their community, as well as their health-related quality of life.[17, 18]

Societal impact – Having impaired executive functions comes at a substantial societal cost. The Dunedin Multidisciplinary Study has analysed the contribution of participants to multiple health and social measures of economic burden, including the duration on a social welfare benefit, the number of criminal convictions, and hospital stays. It was shown that just 20 percent of study participants accounted for nearly 80 percent of adult economic burden. That is, overall societal costs were disproportionately incurred by a small group.[19] Most compellingly, participants were more likely to end up in the high-cost group if they had shown poorer executive functions and experienced other childhood adversities such as socioeconomic deprivation at age three.

The finding of a small, high-needs group posing disproportionate societal burden has also been replicated in nationwide data from 1.7 million New Zealanders. In analysing each measure of economic burden, it was found that the top 10 percent of highest-need New Zealanders used 73 percent of welfare benefits, occupied 86 percent of nightly hospital stays, and accounted for 100 percent of all criminal convictions.[20] When the nationwide data was integrated with the Dunedin data, it was again found that having poorer executive functions could predict whether individuals would end up in the highest-needs groups later in life.

Individuals with higher societal impact are likely to pass on similar socioeconomic, educational and other limitations to their children, who are in turn at greater risk of also imposing heavy burdens on society. This form of intergenerational disadvantage tends to become reinforced in a feedback loop with cumulative effects. Therefore, to help break the cycle, it is important to reliably identify and appropriately support children at risk of poor executive functions by using proven interventions.[21]

Risk factors for suboptimal executive functions

Socioeconomic status – Lower socioeconomic status is a consistent predictor of poorer performance on measures of executive functions during childhood.[22] Lower socioeconomic status is also a well-known risk factor for emotional and behavioural disorders in children and young people,[23] and it is clear that having impaired executive functions is a major mechanism underlying this relationship.[7] Impaired executive functions also explains how child poverty can disrupt long-term academic success.[24, 25] Collectively, this demonstrates that impaired executive functions and low socioeconomic status are interwoven drivers of intergenerational disadvantage.

Nonetheless, it should be noted that the development of executive functions is influenced not only by the economic circumstances in which a child grows up, but also by their broader social and cultural environment. These factors include the strength of their cultural/spiritual identity and, for Māori, the impact of colonialism on hauora.[26] All these aspects may interact with economic challenges to interfere with the development of optimal executive functions.

Maternal mental health – Recent research has shown that a woman's mental wellbeing during pregnancy plays an important role in the development of her child's executive functions.[27] Children whose mothers had depression or anxiety while pregnant tend to show differences in brain structure and connectivity at birth, and later display impaired executive functions as reflected in poorer school readiness and literacy skills.[28] Once they reach adulthood, these children may in turn be more susceptible to poor mental health during pregnancy, adversely affecting their own children's development of executive functions. The result is a vicious intergenerational cycle of women with compromised executive functions having children similarly affected and enduring a lifetime of disadvantage. Impaired executive functions are also seen in children whose mothers experienced milder depressive symptoms, suggesting a large proportion of pregnancies may be affected.[28, 29] However, this also means that even modest improvements in maternal mental health may have meaningful positive impact on their child's executive functions.

Other risk factors – Other factors linked to development of impaired executive functions include exposure to toxic substances and/or nutrition *in utero*; psychosocial stressors during early childhood, such as psychological and physical abuse; and conflictual family dynamics.[30] These factors are themselves deeply interwoven with low socioeconomic status and poor maternal mental health. High exposure to passive, non-educational screen time, an issue of increasing concern in New Zealand,[31] is linked to poorer emotional control and inattention in young children; these effects are likely context dependent, as supervised use of appropriate digital tools may, in fact, promote self-regulation.[i] There is also growing research that dietary intake of micronutrients such as iron and omega-3 fatty acids may facilitate brain development and promote executive functions.[33] This suggests children whose nutrition is unbalanced may also be disadvantaged.

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i The effects of screen time on children's socioemotional and cognitive development are discussed in more detail in another Koi Tū report.[32]

HOW CAN WE PROMOTE OPTIMAL EXECUTIVE FUNCTIONS?

Early intervention is key

Executive functions are critical for prosocial behaviour and academic success, and hence their compromise has pervasive effects on almost every aspect of daily life. Nevertheless, executive functions are malleable and responsive to treatment, and although they can be improved later in life, early intervention is clearly the most logical and cost-effective approach to reduce the risks of lifelong downstream disadvantages.[34]

The effect of maternal mental health on the development of executive functions shows that the foundational pathways begin to be established *in utero*, and that interventions should begin as early as during pregnancy and the early postnatal period. We have previously discussed the need for all pregnant women to be formally screened for their mood, and for those who are affected to a mild/moderate extent to be provided with support.[27]

Both universal and targeted interventions during infancy and childhood can also confer sizeable benefits. A large body of research over the past two decades has focused on early childhood development of executive functions and outcomes in the high school and subsequent years. Intensive preschool intervention programmes for young children at risk of school failure, such as the High/Scope Perry Preschool Study in the US, have been remarkably effective and led to increased rates of high school completion, greater levels of employment, higher income, and reduced criminal activity and welfare reliance.[35] In New Zealand, a randomised controlled trial is under way to evaluate the effect of two evidence-based programmes involving games, exercise and high-quality adult-child interactions on children's self-regulation and oral language skills.[36] Good oral language skills predict improved self-regulation and lower risk of psychopathology (mental disorders and the resulting behaviours) over time.[37]

A new way of thinking about a significant problem

Unlike specific clinical disorders that can be formally diagnosed and treated with medication, impairments of executive functions require a very different understanding to address the problem.[ii]

These impairments are likely to be far more pervasive than commonly thought, so addressing this requires a population health approach involving universal interventions that not only prevent impairments, but also enhance executive functions throughout the population. Hence, the focus should be on promoting brain health, including the quality of mental health and wellbeing, so that every child reaches their maximum capacity for learning, creativity and productivity – the essence of human capital, and a prerequisite to social capital.

Therefore, a whole-of-society, whole-of-government recognition of the importance of optimising executive functions is required. Specific consideration is needed across all domains of policy development, including health, social development, education and justice. Evidence suggests that the priority issues to address are: prevention of impairment, identification of the most at-risk children for early intervention, and development of evidence-informed policies on remediation.

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ii While this applies to most individuals with impaired executive functions, the exception is attention deficit hyperactivity disorder (ADHD), which reflects the extreme end of poor executive functions and can be partially treated with medication.

Although this evidence brief has described the cumulative effect of disadvantage over the life course, the same applies to the advantages gained from early intervention. It has been pointed out that "investing in disadvantaged young children is a rare public policy with no equity-efficiency tradeoff" – that is, the investment both reduces the inequalities experienced by a child simply by accident of birth, and raises the productivity of wider society, with no tradeoffs being incurred.[38] Therefore, in addition to the moral imperative, there is a compelling economic argument to invest in young children and provide the opportunity for proper development of executive functions, as this benefits not only the children themselves, but also wider society and future generations.

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