Brainwave
build a lifetime in the first three years

Submission on:	"Alcohol In Our Lives": a discussion document of the Law Commission
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Area of Concern:	This submission is concerned principally with the following 'Questions for the Public' listed in the summary discussion document: **The Harm:** 1, 3, 4 **Supply Controls, Age:** 14, 15 **General:** 31

1. Introduction

1.1. Brainwave Trust Aotearoa is a registered charitable trust (CC40312) which disseminates information about the recent advances in our understanding of brain development.

1.2. We make this submission to provide the scientific evidence on brain development which can inform the decision-making process for the Law Commission, particularly as it pertains to alcohol use in adolescence and in pregnancy.

1.3. Brain development throughout life is extremely complex but significant advances have been made especially in the last 10-15 years. The field of neuroscience is always changing. This submission reflects current understanding.

1.4. In the interests of brevity and clarity, extremely complex processes have necessarily been described in this submission in greatly simplified terms.

1.5. Brainwave Trust Aotearoa is happy to provide a more detailed verbal presentation to further explain this material.

1.6. Evidence for the material discussed comes from a number of sources including neuro-imaging techniques, animal studies, autopsy findings, blood analysis of hormones, case studies and longitudinal studies.

1.7. We are the first generation of adults and policy makers to have access to this material. Even as recently as 1999 when the decision was made to lower the drinking age in New Zealand, knowledge about brain development in adolescence was not known. We seek to ensure that policies are developed using all the facts that are available.

2. Major Periods of Brain Development

2.1. In the 1990s information regarding the first of two major periods of brain development - the period from conception to 3 years old - became available, thanks in part to the development of non-invasive imaging techniques like MRI, functional MRI and PET scans. From this work we understand that it is the repeated experiences that a young child has – both the good ones and the negative ones - which wire up the brain for life and largely determine whether that child becomes a well-adjusted and contributing member of society and the economy, or a drain on it.

2.2. Until as recently as early this decade, scientists believed that the brain was fully mature by the age of 10-12. Recent findings however have shown a second major period of development - great changes to the parts of the brain that are responsible for self-control, judgment, emotions and organization. These don't occur until the period between puberty and adulthood and are probably not complete until around 25, particularly in young men. This is not a surprise to parents of teenagers and helps to explain the poor decision-making, recklessness and emotional outbursts which characterise the teenage years.

3. Early Brain Development

3.1. The brain is the only organ which is not fully developed at birth.

3.2. Alcohol Use During Pregnancy:

3.2.1. There is no known safe level of alcohol consumption during pregnancy.

3.2.2. Alcohol use during pregnancy is the leading cause of preventable intellectual disability.

3.2.3. Alcohol passes directly into the fetal blood stream. The potential for damage is significant as the fetus is not able to break down the alcohol or excrete it.

3.2.4. Alcohol alters the brain development in an unborn child by affecting the forming brain cells and their axons.

3.2.5. Even modest amounts of alcohol consumed during pregnancy can cause Foetal Alcohol Spectrum Disorders (FASD), a range of outcomes including central nervous system and neuro-developmental abnormalities, low birth weight babies, growth problems and facial abnormalities. The intellectual and neuro-developmental delays are permanent.

3.3. The 100 billion neurons in the brain are wired up at birth to the extent that they are needed to sustain life – to regulate heartbeat and to breathe, for example – and to begin to sustain emotional connection. At birth we are 15% connected and these connections are largely determined by our genes (or "nature").

3.4. We now know that our genes are not a static blueprint but can be switched on or off as a result of sensory experience.

3.5. Particularly from birth onwards, experiences switch on the connections between neurons. These connections are known as synapses. Each sensory experience activates hundreds of surrounding neurons and in this way our brain becomes 'wired' and the other 85% becomes connected. This is determined by our environment, our experiences, our five senses (or "nurture").

3.6. Children brought up in homes that are dysfunctional due to excessive alcohol consumption often lack the repeated positive sensory experiences to develop a healthy brain. Many of these children go on to require support at school and in the justice and health systems.

3.7. The type, the frequency, the intensity and quality, the order and the number of experiences will all have an impact.

3.8. Neurons send their messages chemically and electrically through long projections known as axons which link, or synapse, with other neurons. These links can form nerves.

3.9. Most nerves are eventually coated with myelin, known as white matter. Myelin can be compared with the plastic insulation on electrical wires and enables the rapid transmission of information.

3.10. Myelin is particularly vulnerable to toxic insults in development such as excess cortisol.

3.11. In most areas of the brain these connections or synapse formation and subsequent myelination occurs over the first three years.

3.12. Some time after this, and certainly by age 10, the process begins of pruning or eliminating those connections which are not used frequently. This can be characterized as "use it or lose it". The brain becomes a more efficient and less complicated structure in terms of its neural pathways.

4. The Adolescent Brain

4.1. The behavioural and external physical changes that occur during the teenage years are easily observed. The onset and offset of adolescence is generally operationally defined by these changes e.g. puberty, socialization with peers rather than family, increased risk-taking and exploration as well as the neurobiological changes which occur.

4.2. Research has shown that the adolescent brain is quite different biologically from both the adult brain and the child's brain. It is considered to be "a work in progress" and is not simply an adult brain with fewer miles on the clock.

4.3. There are three particular parts of the brain which are deemed to be works in progress during adolescence. These are:

- Pre-frontal cortex
- Corpus callosum
- Amygdala

4.4. As we get older, better and stronger connections are made between the different regions of the brain. These develop from the back of the brain to the front. The last place to develop and connect is the frontal lobe, the location of the pre-frontal cortex. This myelination may be how adults compensate for not having the great learning potential that children have.

4.5. It seems that there is a second wave of overproduction of gray matter (the cortex), followed by a period of pruning where connections among neurons are either strengthened or deleted – again, "use it or lose it". The pruning is understood to make the brain more efficient as it strengthens the connections that are most used and eliminates the clutter of those that are not used at all.

4.6. The pre-frontal cortex is the area of the brain that controls 'executive functioning' or reasoning and judgment and allows us to control impulsive behaviour. This area of the brain needs to be engaged for safe driving, for example. Prior to 15 or 16 years of age we tend to make decisions based on our emotional rather than our rational thinking. This is sometimes called 'gut reaction' and is based in the amygdala, the part of the limbic system where emotional values are processed. Functional MRI scans show that teenagers, unlike adults, use this part of the brain when making decisions.

4.7. From the early teen years there is a transfer of decision-making to the pre-frontal cortex, the last place to connect, where consideration can then be given to consequences thus blocking us from too much risk-taking behaviour.

4.8. At the same time, the corpus callosum (which is the bundle of fibres which connects the two sides of the brain) changes and grows. This allows problem solving and creativity to develop and assist us in planning.

4.9. Throughout adolescence we slowly become more reasoned, and our decision making reflects the fact that we are increasingly using the pre-frontal cortex in everyday life. Impulse control, planning and an understanding of the rules of conduct become incorporated into our thinking.

4.10. Paradoxically, adolescence is a time when huge amounts of new material in schooling, for example, is being absorbed but good judgment is not always being shown. The ability of adolescents to learn and the physiology which underlies it are well developed, the connectivity is lagging.

4.11. A crucial part of how teens react depends on their experience with the stress hormone, cortisol, in infancy and childhood. Cortisol is a hormone designed to flood the brain for a very short time and to drain away once it is no longer needed. Children exposed to abuse, trauma and long-term stress have brains that are used to living with levels of cortisol which are different from the norm – often elevated, but sometimes also reduced. Many of these teens appear to go out looking for the kind of trouble that might drive cortisol levels and some feel 'normal' only when they have deliberately courted danger.

4.12. There appear to be significant gender differences. Girls' brains reach maturity perhaps more than two years earlier than boys' brains. The myelination and subsequent pruning of connections which is necessary for the brain to become adult-like is not completed until as late as 25 for boys.

5. Drugs and Alcohol and the Adolescent Brain

5.1. The very plasticity described above makes adolescent brains more vulnerable to external stressors – environment, the mates in the back of the car, alcohol and drugs, for example.

5.2. Alcohol affects the developing teen brain differently from the affect on an adult's brain. Research suggests that adolescents are more vulnerable than adults to the affects of alcohol on learning and memory. Not only do they react differently to the initial affects of alcohol, studies suggest that adolescents are also affected differently than adults by repeated, heavy drinking, particularly the repeated withdrawals associated with binge drinking.

5.3. Research, including rat studies, has shown that after alcohol is "washed out", adult cells recover but adolescent cells remain "disabled".

5.4. Marijuana use blocks cell signaling in the brain. The brain is still affected days later in adolescents.

6. Conclusion

6.1. Many children are affected by Foetal Alcohol Spectrum Disorders which are caused by alcohol being consumed during pregnancy. The effects are permanent.

6.2. Young children brought up in homes that have become dysfunctional due to excessive alcohol consumption will often have life long consequences due to insufficient or inappropriate sensory experiences.

6.3. Adolescent brains are not the same as adult brains.

6.4. Judgment, risk taking and decision making are not completely developed until as late as 25 in males.

6.5. Alcohol and drug use have different effects on adolescent brains compared with adult brains.

6.6. Brainwave Trust Aotearoa supports mechanisms which limit alcohol consumption by teenagers, especially young teens.

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