Defence, Safety & Security
Kampweg 55
3769 DE Soesterberg
P.O. Box 23
3769 ZG Soesterberg
The Netherlands

www.tno.nl

T +31 88 866 15 00
F +31 34 635 39 77

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Next Generation Learning: Generation characteristics and trends [V1806]

Date	juni 2019
Author(s)	Dr. J.E. Korteling Drs. T. Hof Drs. M.H.E. 't Hart Dr. R. Wijn
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Summary

Background and method
The world in which we live is evolving at an unpreceded speed. All these changes may have effects on people, especially on the younger ones. This also includes the future (2030) cognitive and social psychological characteristics of next generations of recruits and trainees, who may for instance be affected by an ubiquitous presence of ICT technology. For the Dutch Defense a useful pro-active approach would be to identify and understand the potential learning-relevant characteristics of next generation(s). This will enable the development of cohort-appropriate education and training programs, attracting and retaining young employees, and keeping them on with the pace of the rapidly evolving world. For this purpose, a literature study was carried out within Defence research programme "*Education and (individual) Training (O&iT) in a dynamic operational context*" (2017 – 2021).

Neuro-cognitive differences between generations
This study starts with investigating the development over the last (two) decennia of neuro-cognitive changes in young people in relation to previous generations. According to some authors these changes affect fundamental and generic information processing capacities, such as multi-tasking capacities, general intelligence or working memory capacity. However, a first conclusion from the available theoretical and empirical documentation is that the mainstream of scientific publications does not show such underlying changes in the brain of the most recent generations (Post Millennials, born between about 1985 – 2010).
So, as opposed to what is sometimes conjectured, the rapidly changing world of the Post Millennials has *not* resulted in fundamental and task-independent capacity changes.

Next to that, the literature indicates a *gradual* trend among young people to increasing ICT-related activities (with computers, digital media, internet, mobiles) without strict boundaries between generations. So, the present upcoming "Gen Alpha" (born after 2010) carries forward the computer-related skills of their predecessors, which are easily adopted and then further developed. In line with this we have termed the cognitive changes of the Post Millennial teens as a gradually developing "*Mindset*" (inclinations, preferences, attitudes) and "*Skillset*" (skills, competencies). These result from an overall trend from using legacy media (e.g. books and TV) towards modern ICT applications and social media. Both are associated with "*Snapshot Cognition",* i.e. a more short-cyclic, fragmented, and associative (impulsive) way of information processing and task performance with detrimental effects on deep- and critical thinking)[1].

Social-psychological differences between generations
With regard to social-psychological differences, there is a well-known trend of spending more time using ICT, virtual communications and screens (e.g. social media, gaming). This is related to less preference and experience with regard to in-person social relationships and (softly) to diminished psychological well-being. This latter aspect seems to count more strongly for girls than for boys.
If this trend grows stronger, it might mean that the Defense organization can expect

[1] Concentrated deliberation on complex issues.

that the future employees (especially girls) agree a bit more mentally fragile and insecure than members of the same age from previous generations. Specifically, with regard to work attitudes, a trend is seen toward later maturation into adulthood. This implies that young employees may be less prepared to deal with challenges of the workplace than young members from previous generations. At the same time current teens seem to be less interested in the social and intrinsic values of learning and work. Career progression as reason to go to college has considerably risen in importance in recent years at the expense of joy and inherent utility of learning. They also work more for the extrinsic rewards of working, like earning money. They are more interested in companies and organizations they perceive as stable. Post Millennials also believe that their life is controlled by outside forces instead of they being in control of their life ("external locus of control"). They see more barriers and struggle on their way to success. This might mean that members of the youngest generation, working for the Military, may need a bit more encouragement and praise than their predecessors, resulting from their greater doubts about themselves and their opportunities. The Defense organization and managers might provide more security combined with care to find a hard-working group of young people.

Dealing with upcoming breakthrough technologies

Finally, we briefly address some possible future effects of new, upcoming technologies, such as artificial intelligence, the Internet of Things, and robotics. These breakthrough technologies presumably will have an additional impact on mind- and skillsets and social-psychological characteristics of the young (i.e. those entering the Defense in 2030). So far, however, we could not find any studies or data about the consequences of these current emerging technologies on this upcoming generation. That young people probably will learn intensively to use these new, advanced technologies, does not necessarily imply that they always will deal with it in a responsible, effective, and healthy manner during education and training or in their social life. It is therefore probably more important that the upcoming generations become better aware of the characteristics, possibilities, and drawbacks of these technologies. They will have to learn how to maximally benefit from potential possibilities of (learning) technology and applications embedded in a healthy life style and long-term well-being.

Final considerations and application

Based on this, this study ends with some considerations about the biological and technological evolution of mankind in relation to human well-being. In the modern digital world people interact with a sophisticated technological environment that increasingly differs from our natural environment. This increasing "mismatch" for subsequent generations may also have detrimental consequences for learning and psychological well-being (at work). Next to that, continuous change and uncertainty will probably be the only certainty in the future careers of people. Modern and future education will have to take this into account by providing at least two major overall capacities. First, the permanent ability to learn new competencies, and second, the capacity to mentally cope with unknown and uncertain situations. These capacities are elements of *Individual Adaptability:* the individual ability, skill, disposition, willingness, and/or motivation to change or fit different task, social or environmental features. This relates to the well-known 21th Century Skills, which also include 'Creativity', 'critical thinking', 'problem solving skills', and 'social and cultural skills'. Such skills are certainly not entirely new for the military.

However, with the introduction of sophisticated breakthrough technologies and increasing uncertainty in the world they get more emphasis, requiring a vision about what is really good for us, i.e., what suits human's intrinsic nature and potentials. Only based on such a vision on long-term well-being, choices can be made concerning how to optimally adapt education and training to the youngsters' changing skill- and mindsets.

Contents

1 Introduction and background

The modern world is evolving at an unprecedented speed. This change results from rapid developments in several different areas, such as technology, economy, society and environment (See Appendix 1 for a brief overview of Mega Trends). With this increasing speed of change, the educational system runs the risk of lagging behind, delivering employees that are only fit for yesterday's tasks (European Parliament and the Council, 2006; OECD, 2018; Platform Onderwijs 2032, 2016). Also, by declining birth rates and improved living conditions, Western countries have to deal with aging and dejuvenation. As a result, many companies and organizations may be confronted with a decreasing number of young people on the labor market in order to supplement the growing proportion of older people in the long term. This may threaten the continuity of these organizations. This counts also for the Defense organization, for which it becomes increasingly important to keep up with the major developments in order to be prepared for the challenges of the future (2030).

One major issue concerns the future of education and training. Since global developments (Appendix 1) may have an effect on cognitive and social-psychological characteristics of young recruits and trainees, this probably be relevant for their future educational capabilities, interests and needs. For example, different generations may perceive the world differently, and may differ in how they view their employers and what they expect from the organizations for which they work. Also, individuals across generation cohorts may have different cognitive characteristics and motivations and, therefore, also may differ in learning preferences and -skills and training needs. A helpful pro-active approach would then be to better understand the potential differing (learning-relevant) characteristics and trends of next generation(s) in order to develop and adopt cohort-appropriate education and training programs within the military organization. This will allow the Dutch Defense organization to attract and retain young employees, which is important given the lower influx of new recruits and given increasing numbers of drop-outs and lateral entrants. Besides, this is important to adequately and innovatively educate them using new suitable didactic methods, learning environments, and techniques. Finally, it is important to motivate and stimulate young employees to continuously develop themselves in order to keep on with the pace of the rapidly evolving world. In this connection, the literature study reported here was performed within Defence research programme V1806, *Education and (individual) Training (O&iT) in a dynamic operational context*. The aim of programme V1806 is to develop knowledge about how flexibilization of education and individual training can strengthen the effectivity of learning processes in order to meet the changing operational requirements. New innovative education and training concepts, with a focus on flexibility and effectivity, are explored and investigated in evidence-based research.

Current discussions about educational policy and practice are often embedded in a mind-frame that considers young students as born and developed in an age of digital technology (internet, social media) and societal change.

Previously, these new ‘generations’ were characterized with names such as the (Inter) Net Geners (Tapscott, 1997), Digital Natives (Prensky, 2001a), iGen (Twenge, 2017), or Millennials (Howe & Strauss, 2000) suggesting a preference for networks, digital technology and online activities. In this report we will focus on the students who grew up with computers and the internet, that is the group of Post-Millennials. These youngsters, born after about 1995, have often engaged themselves in the use of information and communication technology (ICT) tools and in accessing, creating, and sharing text and videos on the Web in their leisure life (Junco, 2012). The ability of Post Millennials to embrace ICT suggests that they possess a certain level of “digital literacy”. Digital (ICT) literacy has been defined as the use of digital technology, communication tools, and networks to access, manage, integrate, evaluate, and create information to function in a knowledge society (ICT Literacy Panel, 2002). An important question we will try to answer is to what extent, on the basis of these omnipresent digitalization, future students and young workers have to be considered as *fundamentally different learners* from previous generations of students. If that is the case, these differences in (learning) characteristics between generations may justify a fundamentally different approach to education.
This means that other and new suitable didactic methods, learning environments, and techniques might be necessary to achieve good (optimal) learning outcomes for recent and new cohorts, or ‘generations’, of learners. In this connection, we will focus on possible differential effects of the most relevant personal characteristics, such as gender and educational level.

In Chapter 2 of this report the concept of generations is described. Next, in Chapter 3 and 4 the grounding and nature of differences among generations is described more thoroughly. This is described from a neuro-cognitive (Chapter 3) and a social-psychological perspective (Chapter 4) on training and education. In this endeavor we also discuss to what extent differences between generations are fundamental and ‘hard’ and with that, to what extent the concept of subsequent ‘generations’ is factually grounded. Elaborating on the megatrends described in the Appendix, possible effects of the most recent technologies (i.e. social media) and upcoming, groundbreaking technologies, such as artificial intelligence, are addressed more deeply in Chapter 5. Finally, in Chapter 6 we summarize and state our main findings and we provide visions and perspectives that may be most relevant for future learners in a highly technological society. These insights may help the Dutch Defense organization to better understand the youngest generation entering the workforce in 2030, and to adapt future training and education, if necessary.

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2 The concept of generations

2.1 Introduction

Many studies have examined characteristics of recent cohorts, which are labeled as: '(Post- or Neo-) Millennials', 'Net generation', Generation X, Y, Z, or generation Alpha'. This prior research on generations has resulted in a number of slightly different taxonomies, or categorizations with different generation labels and time frames, as shown in Table 1.

Author	**1945-1964**	**1965-1979**	**1980-1994**	**1995-2010**	**2010-2025**
Nagy (2017)		Gen. X	Gen. Y	Gen. Z	Gen Alpha
Twenge (2017)	Babyboomers	Gen X	Generation Me	iGen	
Suderman (2016)	Babyboomers	Gen. X	Gen. Y	Gen.Z	Gen. Alpha
Székely (2014)		Gen. X	Gen Y	Gen. Z	Gen Alpha
Caspian (2008)	Babyboomers	Gen. X	Gen. Y	Post Millennials	
Li (2007)	Babyboomers	Gen. X	Gen. Y	Youth	
Dede (2004)	Babyboomers	Gen Inbetween	Millennials	Neo millennials	
Lyons (2003)[2]	Babyboomers	Gen X	Gen Y		
Prenski (2001)	Digital immigrants		Digital natives		

Table 1 Shows some different classifications of the age groups (categorized according to the earliest and last birth years).

The most recent generations of youngsters (born from about 1985/90 to 2010) is taken together as one cohort that has grown up with computers and the internet, i.e. the *Post Millennial*. This term includes the youngest part of Gen Y (1980-1995) and Gen Z (1995-2010). It should be noted that these generational categories mainly reflect *tendencies*, not certainties or inevitabilities. Although the generational cohort concept is an intuitive social categorization — just like other types of demographic categories based on for example gender or age — one must be attentive not to overgeneralize. Not all of the members of a generational cohort can be tarred with the same brush. This means that (learning-related) characteristics and trends linked to the Post Millennial generation and the upcoming generation after that (for now Gen "Alpha") should be read keeping in mind that they describe an average, or prototypical, member of a generation, but that (substantial) differences still may apply. In the following chapters we will highlight relevant characteristics that may differ between recent generations and older generations as a result of unique technological, social, and historical contexts.
We also try to shed light on the magnitude of these differences and on possible consequences for future students (cf. 2030).

[2] Also used by Howe & Strauss, 2009, Yu & Miller (2005 & by Woudward et al (2015).

Following Woodward, Vongswasdi & More (2015) we define generation as follows: "*Generations are cohorts of individuals who have grown up in the same historical and social context, whose shared informative experiences instill in them beliefs, values, and general dispositions that differ from those of others born and raised in different contexts and time periods*." (Woodward, et al., 2015, p.9).

2.2 Method

To provide the military organization a clear picture of generations, we have summarized and interpreted the empirical evidence on relevant characteristics and differences associated with generations. We have described the generational characteristics and trends commonly employed in academic as well as popular literature to define generations' similarities and differences that appear to be relevant for workplace learning and education. To be able to draw conclusions about generational trends it is methodologically sound to examine research results that span multiple generations, and not to rely on one-time polls or surveys without comparison group. For example, to observe differences and similarities between Gen Y and other generations it is needed to bring together research that analyzed data collected across time (longitudinal studies) which makes it possible to compare Gen Y to previous generations when their members were about the same age.
In this way the findings pertain to sociocultural changes and not to age, and, therefore, can help to better understand the uniqueness of generations.
The generational trends we describe in this report stem from studies mainly based on US data samples. Consequently, conclusions from these studies cannot be directly generalized to other countries. However, Dutch researchers also examined many of the same trends in media use, time use, psychological well-being, etcetera. So, where appropriate we combined US and NL findings to sketch the overall developments.

3 Neuro-cognitive differences between generations

In this chapter the grounding and nature of differences among generations is described more thoroughly from a (neuro)cognitive perspective. An investigating of the development over the last (two) decennia of neuro-cognitive changes in young people in relation to previous generations is presented.

3.1 Structural changes in brain functioning

According to Tapscott (2009), interaction with digital technology has fundamentally changed the youngsters' brains. It has provided them with distinct and unique capacities and characteristics that set them apart from previous generations. They have higher visual acuity and are better at spatial awareness. For example, playing video games has benefited them in better hand-eye coordination (Green & Bavelier, 2003) and they are considered to be smarter and more effective decision makers and collaborators (Greenfield,1998; Latham, Patston & Tippett, 2013). They are skilled at quickly and frequently jumping and zooming from site to site, sorting, sifting and assessing multiple information. Supposed new capacities of Post Millennials include:

- A higher intelligence than their predecessors (Tapscott, 1997; Howe & Strauss, 2000).
- Critical thinking skills, highly independent, less subservient to authority, more open, innovative and curious (Tapscott; 1997; Dede, 2004; Pallof & Pratt, 2003).
- Fluent in the digital language of computers, video games and the Internet' Speaking a "digital language" (Prensky, 2001;2005).
- Different brain structure, short span of attention (Oblinger & Oblinger, 2005; Opaschowski, 1999; Prensky, 2001, Tapscott, 2009).
- More specialized brains (Merzenich cited by Turk, 2017)

These rather strong claims imply not only differentiation on a functional level (i.e. specific new and other preferences and skills) but also more *structural* changes in the organization and capacities of the brains in Post Millennials. These structural changes are supposed to go further than the neural changes resulting from *normal* learning and experience that always establish neural adaptations and change of neural associative circuitry (e.g., Aydin et al., 2007; Cannonieri et al., 2007; Gaser & Schlaug, 2003; Hebb, 1948). These changes are thus considered more fundamental and relatively independent (generic) of the specific characteristics of the learned tasks. On the basis of this, Tapscott (1997) ultimately writes about the "Net generation" with a high sense of urgency, advocating for recognition of the educational changes that are needed to match to what he sees as the needs of a "uniquely technology-driven" group.

However, on theoretical grounds it is questionable whether the ubiquitous presence of ICT technology in the lives of the Post Millennials has resulted in such generic, structural capacity changes. The brain is a highly flexible, elastic, and adaptive system. Performance improvements (e.g. by education and training) are always established by the formation of new brain "programs" and neural circuits, activated by specific aspects or recurring patterns in tasks, such that the learner can effectively use these new kinds of information (e.g., Mills et al, 2014a, 2014b, 2016).

This is a highly task-specific process. A skilled individual has learned to detect new stimulus constellations and execute new patterns of actions, not just do old things quicker, intermittently, more efficient, or without conscious attention. The neuronal commands of a skilled piano player are thus very different from those when he was a novice (e.g., Aydin et al., 2007; Cannonieri et al., 2007; Gaser & Schlaug, 2003). Therefore, cognitive capabilities are not determined by fundamental underlying (generic) capacities but should be conceived exclusively a matter of dynamic growth and qualitative enhancement of task-specific skills (e.g., Neisser; 1976; Hirst, 1986). In this way, the frequent use of internet and other digital technologies by Post Millennials may have stimulated the development of specific "digital" skills.

Next to this theoretical argument, various researchers have studied the empirical or practical relevance and gained evidence concerning these major claims (e.g., Bennet, Maton & Kervin, 2008; Dux et al., 2006; van Emmerik & Korteling, 2009; Hesel and May, 2007; Westwell, 2007). The overall picture emerging from the literature shows little evidence directly supporting these contentions of Prensky, Tapscott, and other researchers. According to van Emmerik & Korteling (2009) the supposed dichotomy between Post Millennials and the previous Digital Immigrants and Millennials creates an artificial and fundamental boundary between groups that hold neither in the theoretical literature nor in empirical or practical studies. As some of these authors acknowledge, individual differences within groups are larger than the differences between groups (see text box below). Moreover, many specific claims about the Post Millennials could be refuted by actual data. According Hesel and May (2007), the widespread adherence to the idea of an Internet generation can be explained by the Forer effect: "*People are highly disposed to accept vague, generalized, positive personality descriptions as uniquely applicable to themselves (or, in this case, their children).*" p.21.

How to account for large individual differences within groups?

To account for the large individual differences between users of technology it might be more productive to distinguish them on their participation in technology than year of birth. Li (2007), for example, distinguishes six types of users by their level of participation in social computing behavior: Creators, Critics, Collectors, Joiners, Spectators, Inactives. The Creators are the most active group, publishing blogs, maintain web pages or upload material to You Tube more than once a month, whereas the inactives do not participate in social computing activities. Li (2007) surveyed data representing these different types of on-line activity. It was shown that digital media usage is far higher for the younger generations and those young users assume many different roles. Furthermore, still 20% of Generation Y (Millennials) belonged to the inactives whereas 54% was mainly consuming (and not producing). Therefore, it may in some cases be more useful to abandon the artificial boundaries between generations and focus on the way individuals use and interact with internet technology. On the basis of this lack of homogeneity in the population Kennedy et al. (2008) concluded that, with regard to access and use of modern technologies, a major adaptation of school curricula in itself cannot be justified. There is no empirical argument to label an entire generation as Millennial or Post Millennial. The large differences between individuals within an age group argue against such a unitary approach. Furthermore, the differences that appear between generations -if any- at the most suggest a gradual change rather than a revolution.

On the basis of an abundance of evidence, Kirchner & De Bruyckere (2017) also argue that children, adolescents and young adults who have been immersed in digital technologies all their lives are not fundamentally different from previous generations of students. They mention and discuss an high number of research studies (e.g., Bullen, Morgan, Belfer & Qayyum, 2008; Ebner, Schiefner, & Nagler, 2008; Kennedy et al., 2007; Kvavik, 2005; Rowlands et al, 2008; Selwyn, 2009) in a number of different countries and cultures (e.g., Austria, Australia, Canada, Switzerland, the United States) all questioning whether the Post Millennial (or the digital native, as they call them) actually really exists. In strong contrast to popular portrayals of recent generations, all these studies conclude that the Post Millennial does *not* have a deep knowledge of technology. Furthermore, the knowledge they do have is often limited to the possibilities and use of basic (office suite) skills, emailing, text messaging, Facebook, and surfing the Internet. Young people seem much more concerned with the manifold things they have or want to do all the time (studying, working, sports, vacation, partying) and which version of themselves they want to show in their real-world and internet activities. Enhanced functionalities of the available technologies for learning is mostly limited to relatively passive consumption of information or for downloading lecture notes (e.g., Bullen et al, 2008). In line with this, Rowlands et al. (2008) concluded: "… *that the ubiquitous presence of technology in the Post Millennial' lives has not resulted in improved information retrieval, information seeking or evaluation skills."* Selwyn (2009) notes that young people's engagements with digital technologies are varied and often unspectacular. According to Kennedy and Fox (2013) they are using digital technology primarily for "*personal empowerment and entertainment and not so much for supporting their learning*." Finally, Hargittai and Hinnant (2008) found that among people 50 and under, there was no relationship between age and Internet know-how (see also: Hargittai, 2010; Romero, Guitert, Sangra, and Bullen (2013). Rather, higher income and higher education appear positively related to digital literacy.

Overall, it may be concluded that exposure to technology and environmental transitions affects the experiences, preferences, activities and skills of people during their lives. And with that individuals' brains, plastic as they are, will adapt, learn, and develop circuitry to cope with these changes. In this way, new generations may develop different skills adapted to the characteristics of the changing world in which they live. But it seems not very likely that these learned adaptations (skills) involve real structural or fundamental transformations of brain functioning that can provide young people with distinct and unique basic capacities that set them apart from previous generations.

3.2 Multi-tasking

Multi-tasking (or time-sharing) skills are prominently represented in literature on effects of digital technology on youth. Therefore, it is worth to take a closer look on this ability and the evidence whether or not frequent use of internet technology by the youth may have stimulated the development of new capacities and skills.
On the basis of an abundance of studies, Korteling (1994) and Wickens (1992) note that multi-tasking performance improves with practice (just like single-task performance) can be improved by training.

However, the amount of transfer of training from one task to another, different, time-sharing task mostly appears rather small relative to the training-related increase in task performance for each time-sharing task seperately (e.g., Damos and Wickens, 1980). For example, if you learn to simultaneously engage in social media activities, while working at a computer, this probably will not result in better listening to the radio news during car driving or to better performances in simultaneously learning a history lesson and playing chess. It should thus be noted that learned time-sharing skills are rather specific for the given multi-task combination that has been trained. Time-sharing is not a generic skill that enhance all kinds of multiple-task performances, irrespective of the specific tasks or task-combinations involved.

With this in mind the review on this topic in relation to the most recent generations by Kirchner & De Bruyckere (2017) may again be considered. According to this review, these generations have been ascribed the ability to cognitively process multiple sources of information simultaneously (i.e., they can multitask). As a result, teachers, educational administrators, policy makers and the media think that today's young people require an educational approach radically different from that of previous generations. However, Kirchner & De Bruyckere (2017) present evidence that the ability to multitask does not exist for cognitive tasks that require attention (i.e. non-automatic tasks). What people really mean when they say that a person is able or good at multitasking is that this person has developed the ability to quickly switch between carrying out different tasks or using different media (Dux et al., 2006). However, though young students apparently do this, it does not mean that doing so is beneficial for their overall productivity (task performance) and for learning (e.g. Westwell, 2007). It has been broadly shown that rapid switching behavior, when compared to carrying out tasks serially, leads to poorer learning results in students and poorer performance of the tasks being carried out (Rogers & Monsell, 1995; Rubinstein, Meyer, & Evans, 2001). This is primarily due to the fact that switching between subtasks leads to greater inefficiency in performing each individual task, namely that more mistakes are made and it takes significantly longer as compared to sequential work. In other words: "performing two or more cognitive (non-automatic) tasks simultaneously takes a toll on productivity".
They also conclude that designing education assuming the presence of this a multi-tasking ability hinders rather than helps learning. So, irrespective of the hypothetical possibility that the most recent generations might be better switchers, education should strongly discourage doing so. Constantly switching between tasks will lead people to losing the opportunity, and ultimately the ability, to more longitudinal, deep and concentrated thinking and problem solving.

3.3 'Soft' distinctions among generations: Mindset and Skillset

Given the lack of hard evidence, we do not perceive strict boundaries between generations; distinctions in characteristics are rather gradual and show many colors grey. Therefore, we prefer here to define the changes more "softly" as a gradually developing new "*Mindset*" and "*Skillset*", both consisting of a number of physical, cognitive, and social-psychological (mental) attributes/characteristics that are grounded in an ever-increased exposure and proficiency with regard to digital technology. The mindset includes inclinations, preferences, and attitudes; the skillset concerns the behavioral capabilities in relation to the (daily) use of tooling and applications (e.g. improving computer-, internet-, and multi-media skills, integrated with private-, social- and (later) professional life).

Both the mind- and skillsets may be considered less pervasive and more malleable than supposed structural neuro-cognitive capacities, that are independent of the specific task involved. Nevertheless, a set of characteristics (mindset- and skillset-attributes) can be identified that pertain specifically to the youngest generation (Frand, 2000; Smith, 2012; Tapscott, 2009):

Mindset

- Less physical activity;
- Less memorization;
- More digital on-line information processing, less from legacy media;
- Positive about multitasking;
- Blurring of consumer/creator, work/play, and public/private;
- Preferring to learn and work collaboratively in a safe environment;
- Less interested in knowledge of facts and how things really work (doing rather than knowing).

Skillset

- Improved computer-, internet-, and multi-media skills;
- Integration/sharing of these skills in private-, social-, educational, and (later) professional life;
- Less skilled in (long-term) focused attention and probably less skilled in deep/critical thinking;
- Skilled in a short-cyclical and more associatively way of working.

With our conceptions of Mind- and Skillset evolution we here advocate a rather "soft" distinction between generations, without distinct or hard boundaries. Notwithstanding the aforementioned critics (e.g., van Emmerik & Korteling, 2009; Kirchner and Bruyckere 2017) with regard to the empirical evidence and the robustness, discreteness and consistency of some data, we consider the gradual development of an accompanying 'information age' mind- and skillset as real, significant, and very relevant for military training and education. For example, it is supposed that memorization aptitudes of new generations have decreased, but omnipresent internet access may make those less necessary (e.g., Tapscott, 2009).

The omnipresent availability of data seems to have resulted in more fragmented processing of multiple information, less memorization skills, less knowledge of facts, and more virtual (social) connection with others. We term this way of information processing '*Snapshot Cognition'.* Snapshot Cognition may have some detrimental effects on deep- and critical thinking skills, requiring more concentration and focused attention. Next to that, although all information needed may be available on the internet (instead of in the brain) how do you know *what information* should be looked up on the internet? How do you know which problems you have to solve or how to start and proceed with analyzing and step by step solving a (complex) problem? For example: which associated (underlying) questions you should ask yourself? And how can you then come to creative combination of information from a variety of different sources? A possible answer to this question might be: by discussing and close collaborating with others (who have other and different knowledge and experience), because you do not have sufficient top-of-mind knowledge to do it alone (reference missing). We will further address this issue in the Chapter 6.

3.4 Generation “Alpha”

So far, the most data concerning differences between generations concern the Millennials and Post Millennials, born before 2010. Very relevant for the present study is the surmised Gen Alpha, born after 2010 (Nagy, 2017; Suderman, 2016; Székely 2014). This is the generation that will enter the Defense organization around 2030. Of course, there cannot yet be much empirical data available to substantiate this contention of a distinct new generation. On the basis of traditional desk research, such as literature search, data mining and web search, Nagy (2017) has tried to disclose the origin of Gen Alpha (Alfa), the possible characteristics attributed to this age group, and to discern if this concept is meaningful in terms of the generation paradigm. He firstly concludes that the existence of X, Y, and Z Gens is demonstrable. Because of the absence of academic studies on the most recent generation (Alpha) he analyzed non-academic sources reporting about this generation in order to get a clearer picture on its existence. On the basis of this, Nagy (2017) concludes that there is no scientific evidence yet for a new Gen Alpha with fundamentally different characteristics. According to the limited data so far, he conjectures that Gen Alpha is basically just “Gen Z 2.0”. This generation seems not that different from its predecessors; it carries forward the legacy of their predecessors, which is then further developed. That is, the Post Millennial preferences and competencies gradually develop and unfold over time where each next generation adopts the attributes of the most recent more easily, more quickly and more profoundly. This includes the continuation (and probably strengthening) of many of the attributes of previous generations, like: increased screen time, high “digital literacy”, more tech savviness, increased social networking, more online shopping, less direct human contact, and less physical activity (relative to previous generations).

Thus, these characteristics seem rather similar to the ones observed in previous Post Millennial generations, who frequently engage themselves in the use of digital technology, communication tools, and networks in order to function in a knowledge society (ICT Literacy Panel, 2002; Junco, 2012). Whereas the existence of X, Y, and Z Gens is demonstrable, it seems too early for scientific evidence indicating a new “Gen Alpha”.

3.5 Conclusions

On the basis theoretical and empirical documentation, it is unlikely that the ubiquitous presence of ICT technology (and maybe other socio-technical circumstances) in the Post Millennials’ lives has resulted in structural, improvements (or deteriorations) in fundamental, task-independent information processing capacities, such as working memory- or multitasking capacity, intelligence, or information detection capacity. Almost all scientific information concerns the fact that young people know and frequently use the possibilities of the various new technological applications. Having grown-up with these, the recent generations have gradually developed a number of other preferences and practices. For example, when using digital media young people more often work short-cyclically and more associatively, (often impulsively responsive), while abandoning legacy sources of information, like face to face conversations and books. Their brains, however, do not function fundamentally differently compared to previous generations.

Also given this lack of evidence, we do not perceive strict boundaries between generations; distinctions in characteristics are rather gradual and show many colors grey. Therefore, we prefer to describe the changes more ‘softly’ as a gradually developing new *Mindset* and *Skillset* of the young. Both consist of a number of physical, cognitive, and social-psychological (mental) attributes/characteristics that are grounded in an ever-increased exposure and proficiency with regard to digital technology. The mindset includes inclinations, preferences, and attitudes; the skillset concerns the behavioral capabilities in relation to the (daily) use of tooling and applications, like improving computer-, internet-, and multi-media skills. These inclinations and skills may be considered less pervasive and more malleable than the supposed fundamental and task-independent changes in neuro-cognitive capacities. This gradually developing mind- and skillset due to omnipresent availability of knowledge may be called *Snapshot cognition*. That is a more fragmented processing of multiple information, less memorization skills, less knowledge of facts, and more virtual (social) connection. This may have detrimental effects on deep- and critical thinking and problem-solving skills.

These conclusions also concern surmised Gen “Alpha”, i.e., the generation born after 2010 (Nagy, 2017; Suderman, 2016; Székely 2014). This is the generation that will enter the Defense organization around 2030. Based on the limited data on these youngsters so far, we suppose that they will also carry forward the mind- and skillsets of their predecessors and develop these further, probably more easily, more quickly and more profoundly.

4 Social-psychological differences between generations

Also, a clear picture of generation trends in media use, time use, psychological well-being, work values, and educational attitudes can help the military to better understand the members of today's and next generations, what to expect from them and how to ultimately accommodate and facilitate their education and training.

4.1 Media use

Twenge, Martin and Spitzberg (2018) studied whether culture change, in this case technological developments and innovations, have influenced how adolescents use new digital media (texting, the Internet, social media, and gaming) and older, legacy media (books, magazines, newspapers, TV, and going to the movies). Twenge et al. (2018) examined and analyzed large, U.S. representative samples that were collected every year from 1976 to 2016 tracking media use over the years among the same age-groups using the same questions. In this study Twenge et al. (2018) found that adolescents aged 16-17 in 2016 differed from their same-age predecessors in previous years in how they use new digital media and legacy media. In 2016, the average American adolescent aged 16 and 17 - both boys and girls from both lower and higher socioeconomic status groups - spent on average six hours a day with digital media, including the Internet, gaming, texting, and social media during leisure time (Twenge et al., 2018). These adolescents aged 16 and 17 spent more time online and on gaming in 2016 compared with 2010. The percentage of adolescents aged 16 and 17 who visited social media sites almost every day increased from 63% in 2010 to 82% in 2016. The only downward trend found in this study (Twenge et al. 2018) was texting, which adolescents aged 16 and 17 said spending 24 fewer minutes a day on in 2016 compared to 2010. At the same time, Twenge et al. (2018) found that these adolescents aged 16 and 17 were spending less time on legacy media (books, magazines, newspapers, TV, and going to the movies): in 2016, only 16% of adolescents aged 16 and 17 reported reading a book or magazine almost every day; in the late 1970's still 60% did. These found differences in new digital media use and legacy media use were rather even across gender and socioeconomic status groups.

A similar pattern regarding more social media use and gaming and less reading books has been found for Dutch teens in the study by Van Dorsselaer, et al. (2016). In 2015, 83% of Dutch adolescents aged 12 to 16 visited social media sites almost every day. More girls (89%) than boys (76%) are daily visitors of social media sites. And 68% of Dutch adolescents aged 12 to 16 play games regularly (68%) or almost every day (27%). Boys (44%) are more often regular game players than girls (9%). Regarding reading books, Dutch adolescents aged 13 to 19 spent 10 minutes a day on reading a book in 2015. This is substantially less than in 2013 when they still spent 23 minutes a day on reading books ($p<.01$, Wennekers, van Troost, & Wiegman, 2016). Recent research from 2018 by Wennekers, Huysmans and De Haan confirmed this trend towards teens spending less time on reading than teens from previous generations ($p<.05$).

This trend from using legacy media less to using new digital media more - for both boys and girls from both lower and higher socioeconomic status groups - means that the Defense organization probably can expect that new and future employees will have less experience reading long-form print, especially books. In addition, it can be expected that new and future employees will probably have less practice and experience with regard to in-person social skills (Twenge, 2017).

4.2 Psychological well-being

Twenge (2017) sketched a rather gloomy picture about psychological well-being of American adolescents aged 13 - 18. The psychological well-being of the average American adolescent aged 13 - 18 dropped noticeably between 2012 and 2016 (Twenge, Martin & Campbell, 2017). Self-esteem, happiness and satisfaction with life and with themselves declined with an average effect size of d = -.14 which is, although traditionally considered small, being seen as an unusual degree of change in the context of the very brief 4-year period over which the change happened. This decline in adolescents' psychological well-being has been associated with the trend in how they spend their social time. Twenge, Martin and Campbell (2017) found that adolescents aged 13 - 18 who spent more time on electronic communications and screens (e.g., social media, gaming) had lower psychological well-being. On the other hand, adolescents aged 13 - 18 who spent more time on non-screen activities (e.g., in-person social interaction, sports/exercise, homework, print media) had higher psychological well-being. These links between in-person social interaction, (social) media use and psychological well-being do not necessarily imply a causal relationship.

This decrease in psychological well-being seems also to appear - however less prominent - in Dutch adolescents. In the four-yearly HBSC study, Stevens et. al. (2018) found that Dutch adolescents in primary education (11 years old) and high school (aged 12 - 16) were rather satisfied with their lives. In 2017, primary education boys and girls aged 11 reported an 8.3 on a scale from 1 to 10. And high school boys and girls (12 – 16) reported a 7.6 on a scale from 1 to 10. Nonetheless, these self-reported scores on psychological well-being were a bit - though significantly - lower than the reported marks in 2001: elementary education students aged 11 reported then an 8.6 and high school students (aged 12 – 16 reported then a score of 8). Another finding that was similar to the US pattern pertained to experiencing hyperactivity problems. In the Netherlands, the percentage of primary education student (aged 11) reporting to experience hyperactivity problems rose significantly from 18,7% in 2009 to 24% in 2013 and stabilized at 25% in 2017. Significantly more boys (28%) than girls in primary education (22,1%) reported to experience hyperactivity problems in 2017.

The mental health picture appeared the least positive for girls in high schools. In 2013 and 2017, these girls (aged 12 – 16) reported significantly more psychosomatic health complaints, more emotional problems, more behavioral problems, more hyperactivity problems, and more problems with peers, compared to 2009 and 2005. Boys in high school (aged 12 – 16) reported in 2013 and 2017 only significantly more psychosomatic health complaints and hyperactivity problems than in 2005 and 2009. These differences might be related to more extensive social media usage by girls.

Except for emotional problems, considerable differences were found between pre-university education and pre-vocational education[3] students. Students in VWO were significantly more positive about their lives and psychological well-being and reported less often behavioral problems, hyperactivity problems, and problems with peers than their peers in lower educational levels.

Although there is a slight trend towards diminished psychological well-being, Dutch adolescents are still considered the most happy in the world (e.g. the Guardian, 2018). If this trend grows stronger, it might mean that the Defense organization can expect that new and future employees will be a bit more mentally fragile and more self-doubting than members of the same age from previous generations. This may count a little bit more for girls than for boys.

4.3 Maturation into adulthood

American adolescents (aged 16 and 17) of every racial group, region, class and gender appear to grow up more slowly as measured in 2015 than same-age adolescents in 2009 (Twenge, 2017). Nowadays, US adolescents engage later in activities associated with adulthood, such as having sex, dating, drinking alcohol, working for pay, going out without one's parents, and car driving than adolescents in previous decades did (Twenge & Park, 2017). In the Netherlands, similar trends regarding alcohol use, smoking, and having sex, have been found (Bakker, de Wilde, & Kooijman, 2015). In 2013, Dutch adolescents (aged 12 – 16, boys and girls from all educational levels) drank less alcohol and started drinking at a later age than Dutch adolescents aged 12 – 16 did in previous decades. The same patterns holds for smoking and having sex.

And also, in almost all advanced industrial democracies the transition into adulthood takes nowadays place later in life compared to previous generations. It takes young adults longer to settle into adult roles. In the past decades young adults experienced many life-cycle events (such as being married or cohabiting, having children, owning a home, and having a job) at a higher average age than their parents and grandparents did. A recent study by Smith et al. (2017) found that men as well as women emerging into adulthood (mean age of 20) were more reluctant and fearful to mature in 2012 than same-age cohorts in 1982, 1992, and 2002. This slower developmental path into adulthood is also associated with a delayed uptake of adult responsibilities, such as voting (Smets, 2016), managing own money (Twenge, 2017), having a (summer) job (Twenge, 2017), or having a driver's license (Thigpen & Handy, 2018). Groen and Vuijsje (2016) described a similar trend. In the Netherlands, the period of growing into adulthood has also lengthened for the youngest generation. Dutch adolescents lived longer at home with their parents and found a job later than same-age adolescents from previous generations. The report Mobiliteitsbeeld 2017 (Kennisinstituut voor Mobiliteitsbeleid, 2017) also confirmed that Dutch young adults' car ownership diminished between 2005 and 2016 with almost 10%, from 313 cars per 1000 persons in 2005 to 284 cars per 1000 persons in 2016. For the Dutch situation, no information is available about gender differences and/or educational differences regarding this trend towards slower maturation into adulthood.

[3] Respectively VWO and VMBO-B in Dutch.

This trend towards a slower and later maturation into adulthood may mean that the Defense organization probably can expect that young employees will be less familiar with adult life and job responsibilities (for example, time management, discipline, work ethic) and may be less prepared to deal with challenges of the workplace than same-age members from previous generations were.

4.4 Work values and attitudes towards education

To describe trends in work values and attitudes towards education, we almost exclusively draw from the work by Twenge (2017). We could hardly find any Dutch research results that we could use to confirm or dismiss the US findings. Still, we think it is important to take notice of US youngsters' attitudes towards education and work values.

Asked about what they wanted out of a job, in 2015 many US adolescents aged 16 - 17 answered that making money is the best part of the job. A small one-time survey performed in the Netherlands in 2018 found a similar result; 81% of 214 Dutch teens aged 15 – 17 said to prefer a stable, secure, well-paying job, compared to Dutch millennials (born 1980 – 2000) who preferred a fun, enjoyable job (Motivaction & YoungCapital, 2018). This seems to be in line with US adolescents (aged 16 – 17) who are saying they are less focused on job attributes such as a job that is interesting, where you can learn new things, and where you can see the results of what you do (Twenge, 2017). The other large difference to previous generations is the diminished importance of the social attributes of a job. Compared to previous generations at the same age, recent adolescents (aged 16 – 17) seem less interested in making friends at work, in jobs where they can interact with lots of people and in face-to-face social interaction at work (Twenge, 2017). They just want the job, so they are able to pay their bills and student debts, but they also feel that work should not overshadow the rest of their life.

Contrary to popular belief (mainly based on one-time surveys without comparison), US adolescents aged 16 - 17 were in 2015 less likely to want to own their own business than Boomers and Gen X'ers were at the same age (Twenge, 2017, p.187). Twenge (2017) also found that American adolescents aged 16 and 17 were interested in stable jobs but seemed less drawn to having jobs in large corporations. However, they were more interested than Millennials (born 1980 – 1995) in industries they perceive as stable, particularly the military and the police force. These potentially physically dangerous jobs were perceived to provide a steady paycheck, with few layoffs, and both these job attributes were considered very attractive.

Twenge (2017) also noted that recent adolescents aged 16 and 17 felt increasingly worried about whether they would be able to succeed in (work) life. They had the feeling that they kept getting stopped by outside forces from getting ahead. They were found to be more external in their locus of control than previous generations. This means that many of them believed that their life is controlled by outside forces instead of they being in control of their life. Therefore, a growing number of adolescents aged 16 and 17 thought that success is just one step too far. This trend may be connected to a less positive mental state of recent adolescents, i.e. anxiety and depression which are linked to pessimistic attitudes such as an external locus of control.

Income equality and the aftermath of the Great Recession may also play a role (Twenge 2017). Compared to previous generations, today's adolescents aged 16 and 17 also see more barriers (lack of ability, lack of knowing the right people, family background, gender discrimination) in their way to success.

This might mean that members of the youngest generation, working for the Military, may need a bit more encouragement and praise than Millennials, resulting from their greater doubts about themselves and their opportunities. The Defense organization and managers might provide security combined with care to find a hard-working group of young people.

American adolescents' (aged 16 and 17) interest in school suddenly fell beginning around 2012; fewer students were saying that they found school, interesting, enjoyable, or meaningful and more students even doubted that what they learned in school was relevant to their lives and future careers (Twenge, 2017). These US adolescents are nowadays more focused on exam grades than on the joy of learning. In addition, the 16 and 17 years old adolescents mentioned that the reason they wanted to go to college was to increase their chances of getting a better-paying job instead of to explore and learn new things (Twenge, 2017). Thus, colleges were less seen as places for learning and exploration and for getting into contact with dissimilar ideas, but more like functional places that should prepare for a career in a safe way (Twenge, 2017).

This might mean that the Defense organization probably can expect that new employees will have less experience in debating controversial issues and are less experienced in face-to-face dealing with difficult issues with their peers or adults. This may mean that new employees will have an increased need for emotional safe learning circumstances.

4.5 Conclusions

The overall trend from legacy media to modern ICT may indicate that future employees (in the Defense organization) may probably have less preference and experience with regard to in-person social relationships. This trend of spending more time on electronic communications and screens (e.g., social media, gaming) is also (softly) related to diminished psychological well-being. With regard to work attitudes, the data indicated a trend toward later maturation into adulthood. At the same time recent teens seem less interested in the social and intrinsic values of work, like social interaction or learning new skills. They seem to work more for the extrinsic rewards of working and are more interested in companies and organizations they perceive as stable. Recent teens also seem to feel relatively more worried about whether they will be able to succeed in (work) life than previous generations, having a more external locus of control. They see more barriers and struggle on their way to success. This means that they may need some more encouragement and support to deal with challenges of the workplace and the real world than same-age members from previous generations.

5 Additional impact of new, upcoming technologies

The previous chapters addressed the empirical evidence on generation differences, primarily as related to the emergence of computer and internet technologies. Here we will briefly address some additional effects or implications of *new*, upcoming breakthrough technologies, such as, data science, artificial intelligence, Internet of Things, and robotics. We will focus on possible future effects relevant to learning and job performance for the upcoming generation ("Alpha") that may enter the Defense in 2030.

5.1 Upcoming technologies for 2030

Empirical studies concerning possible effects on learning behavior (and -motivation) of possible groundbreaking, technologies that are upcoming right at this moment, cannot be carried out yet. Therefore, we only can put forward some preliminary expectations for 2030 on the basis of analysis of upcoming technologies and innovations on the basis of their potential (strong) impact on (learning of) the latest generation of youth. With regard to the new emerging technological developments it is broadly argued that we are on the threshold of a new, critical era of human development (e.g. Bostrom, 2014; Harari, 2018; Tegmark, 2017). According to these authors, the present upsurge of new, groundbreaking technology, will have an undeniable, ever-increasing impact on every aspect of daily life. This rapid technological evolvement will have much impact on the lives, study, and work of the people living in 2030. Like these authors, and many other scientists, we must be aware of both the grand (ánd possibly the disastrous) potentials of technologies such as: gene-engineering, nanotechnology, data science, artificial Intelligence, and robotics.

With regard to human learning and education, the rapid upcoming combination of data science, artificial intelligence (AI)[4], and robotics, may (by far) have the most serious impact. These technologies allow us to handle and process many data (much more, much quicker, and much more reliable) in increasingly smart (intelligent) ways and to put them into action (e.g., Harari, 2017, 2018). Many kinds of imaginable applications that were previously thought impossible (such as emotional and facial recognition) have already proven themselves. Sometimes the use of these techniques leads to performances of systems that are roughly comparable to those of people (e.g. autonomous cars); sometimes it leads to performances that are not available to normal people (e.g. the victories of AI systems on champions in Chess, Go, and Poker). Most experts estimate that in the near future, AI will be able to match and surpass man in many more areas (Bostrom, 2014; Boulanin & Verbruggen, 2017; Korteling et al, 2018; Tegmark, 2017). Sophisticated AI systems will then be able to take over a wide variety of complex tasks from us that up to now have been exclusively reserved for humans. This way, learning analytics and virtual instructor systems may provide powerful adaptive and personalized coaching, education, and training for multiple military tasks and functions. In recent years, in many domains, breakthroughs have already been possible due to the integration of data science, AI, and robotics.

[4] By powerful processors and machine learning.

Examples are on the area of intelligent decision- support processes (cognitive systems), and also on the area of more practical and concrete monitoring, reconnaissance, logistical, and medical tasks. More in specific, these breakthroughs include artificial pharmacist systems, drones and autonomous tractors involved in precision agriculture, autonomously navigating robots in warehouses and container terminals, autonomous cars in urban areas, robots and drones employed for search and rescue missions together with human operators, cyber-physical systems in industry, and a wide range of healthcare applications. In other words, practical applications abound (e.g., Eikelenboom et al, 2018; Harari, 2018).

It may be expected that all these kinds of highly intelligent and sophisticated technological support systems will be used more often and dominantly in the near future. These technologies probably will replace, or substantially change the nature of, many jobs and tasks related to learning and education. Although it is difficult to predict exactly what will change, it is certain that the intensity, diversity and frequency of interactions between humans and AI systems will substantially increase. According to some authors this might, for example, lead to the introduction of “human-AI co-learning” in the defense. It is expected that people will cooperate in hybrid teams consisting of people and intelligent machines who will train and learn collaboratively as an interdependent man-machine team (e.g., Bergstein, 2017; Bosch, van den & Bronkhorst, 2018; Mioch, Peeters & Neerincx, 2018; Parasuraman et al, 2007). In addition, we know that young people are more likely to drive the adoption of new tech-enabled services and systems (Grand-Clement, 2017; RAND Corporation, 2017) and that the youth will be the first to adopt these intelligent support systems and promote them into society, probably with great enthusiasm. Of course, this may have an additional impact on their cognitive and social-psychological preferences and skills. For example, people may prefer to hand down own tasks and responsibilities to intelligent support systems because they know that these systems use to do the job more consistently and often better than humans. Since these future technologies may substantially pervade many aspects of personal, educational and professional life, the magnitude of such tendencies may even overshadow those of the previous effects of ICT, internet- and social media technology. At present, we could not find any studies or data about the possible consequences of new emerging technologies on the learning characteristics of future generations. Below some very first, tentative, and preliminary suspicions about the mind-and skillset of the future generation (entering in 2030) relative to the recent Post-Millennial generations (Gen Z) (reference).

- More use, trust and compliance with regard to intelligent support systems;
- More interaction with virtual realities, mixed realities, and with AI systems;
- As a result of automation, less proficient in basic physical-, perceptual motor-, cognitive and social tasks;
- More experience with, or proficient in, higher-order cognitive, system and goal-setting tasks;
- ‘AI aware’: grasping the functions, possibilities, limitations of intelligent autonomous systems.

There will be high variance between different mind- and skillsets of young people and, in regard of lacking empirical data, how these traits may develop for the future learners and young workers is difficult to estimate. This depends among others on the technological and sociocultural context in which these future young people grow up. For now, we may confine ourselves to the “educated guess” that the upcoming generations should learn how to maximally benefit from potential possibilities of (learning) technology and applications embedded in a healthy life style and long-term well-being. In this respect, one of the first and dominant changes in learning and education (often not fully recognized) will probably be that people will have to learn to really understand and adapt to new AI and related intelligent technologies (like robotics and big data algorithms). This is a learning process that we previously have termed: “*AI-awareness*” (Korteling & Kester, 2019). AI awareness means that people will have to develop a proper mental model about the nature of (upcoming) highly sophisticated and intelligent systems, which includes a good understanding of their global system properties and capacities (characteristics, possibilities and limitations). Since people will increasingly carry out tasks using these intelligent technologies, AI Awareness will enable them to interact and use these systems to their good benefit and health.

5.2 Conclusions

According to the limited data so far, we consider the cohort of people born from around 2010 - 2015 an extension of the Post Millennials. They probably will carry forward the legacy mind-set and skillset of their predecessors (like snapshot cognition) and develop these further. Like in the present, this process will be continually, adapted and moderated on the basis of other future technological, sociocultural, and economic changes. For the near future, major technological developments like AI, virtual reality, robotics, big data, and the Internet of Things may massively pervade and affect the lives of the next generation of students. So, although it is difficult to predict exactly what exactly will change, it is fairly certain that the intensity, diversity and frequency of interactions between humans these technologies will substantially increase. This process will probably develop further and transform over time, for instance towards more “collaboration” with technology instead of just using it. This requires that people will have to become more and better aware of these technologies and develop a proper understanding of their (highly advanced) characteristics, possibilities and potential drawbacks. For the rest, it is well-known that we, as human-beings, tend to be highly overconfident about the certainty of predictions based on current developments (See for instance Dobelli, 2011; Kahneman, 2011). Therefore, we must not overestimate our ability to predict the future and thus remain cautious in making too hard predictions about the ultimate nature and impact of these technologies on the lives of future generations.

6 Conclusions and Discussion

In this final chapter we will briefly refer to our main findings and discuss some possible implications for the future generation of learners and young professionals.

6.1 Cognitive differences: Mindset end skillset

So far, neither the theoretical literature nor empirical studies indicate fundamental changes in basic cognitive capacities in Post Millennials (born between 1985/1990 and 2010). Nevertheless, a gradual trend can be noticed indicating that young people increasingly engage in ICT-related activities (with computers, digital media, internet, mobiles) (Reference). Some authors see this trend as a rather distinct (almost evolutionary) step in the basic information processing capacities (e.g., Tapscott; 2009). However, given the lack of hard evidence, we do not perceive strict boundaries between generations; distinctions in characteristics are rather gradual and show many colors grey. This also counts for the surmised Gen “Alpha”, i.e., the generation born after 2010 and entering the Defense organization around 2030.Therefore, we have described the differences between generations more ‘softly’ as a gradually developing new *Mindset* and *Skillset*. Both these mind- and skillsets consist of a number of physical, cognitive, and social-psychological (mental) attributes/characteristics that are grounded in an ever-increased exposure and proficiency with regard to digital technology. Both the mind- and skillsets may be considered less pervasive and more malleable than supposed structural neuro-cognitive basic capacities, that are independent of the specific task involved.

This gradually developing mind- and skillset due to omnipresent availability of digital information was characterized with the term *Snapshot cognition*. We have circum-scribed this as a more fragmented way of (multiple) information processing, less memorization skills, less knowledge of facts, and more virtual (social) connection. However, many cognitive skills still require a great deal of focused attention. Snapshot cognition may, therefore, have detrimental effects on deep- and critical thinking and problem-solving skills, such as knowing what information should be looked up on the internet and how to creatively combine information from a variety of different sources. Since Post-Millennial and future generations of young people may lack the top-of-mind knowledge and skills to solve these problems alone, they may develop more skills to effectively collaborate with others, who may have other and complementary knowledge and experience.

Here we do not take a position concerning whether or not snapshot cognition should be considered a cognitive improvement or deterioration. Such qualifications will probably be determined by characteristics of the issue, the goals, the actors, and the context. All these kind of perspectives and factors will have to be taken into account when the military organization is considering and analyzing how to prepare for the education and training of future personnel. For example, for certain kinds of complex tasks requiring deep information processing, Post Millennials may need to learn to disengage from distraction. They need to become aware the potential disadvantages and temptations of overstimulation and multi-tasking ("impulse control"), echo chambers (information bubbles), virtualization of social activities, commercial manipulation, and compulsive information consumption (see also Tapscot, 2009).

In addition, education will have to focus on learning to benefit optimally from internet, social media, and other relevant technologies, in the field of learning and professional collaboration and to combine (or separate) this effectively with private, physical, and in-person social activities.

6.2 Social-psychological differences: well-being and work attitudes

Less in-person social relationships and being more occupied with electronic communications and screens (e.g., social media, gaming) seems (softly) related to diminished psychological well-being. If this trend grows stronger, it might mean that the Defense organization can expect the future employees (especially girls) to be a bit more mentally fragile and insecure than members of the same age from previous generations. With regard to work attitudes, the trend towards later maturation into adulthood may imply that young employees may be less familiar with adult life and job responsibilities and may be less prepared to deal with challenges of the workplace than young members from previous generations were. At the same time, recent teens seem less interested in the social and intrinsic values of work, such as social interaction or learning new skills, compared to previous generations. They seem to work more for the extrinsic rewards of working, like earning money and (thus) being able to have a stable and comfortable life. They are more interested in companies and organizations they perceive as stable, such as the military and the police force as these potentially physically dangerous jobs provide a steady paycheck, with few layoffs. Recent teens also seem to feel relatively more worried about whether they will be able to succeed in (work) life than previous generations, having a more external locus of control. They see more barriers and struggle on their way to success. This might mean that recent and new teens, working for the Military, may need a bit more encouragement and praise than Millennials, resulting from their greater doubts about themselves and their opportunities. The Defense organization and managers might provide security combined with care to find a hard-working group of young people.

The internet and the adoption of social media technology has become an inherent, and much debated—part of the functioning of our modern society. In what way and to what degree are the internet and social media improving or harming participation in community life and social relationships? Children already learn intensively how they can use the internet and social media outside school, in leisure time, and probably continue to do so during and after class as an adolescent or adult during further schooling and in their professional life. In this way, online social networking interactions and sharing of information might contribute to increased learning motivation and professional engagement. However, the fact that young people have learned how to handle social media from a young age does not imply that they always will deal with it in a responsible and effective (and healthy) manner during education and training in professional practice, and in their social life. It is therefore probably important that the upcoming generations will have to be better educated how to maximally benefit from potential possibilities/advantages of learning technology and applications in relation to learning embedded in a healthy life style. For example, teachers may utilize social media to increase learning motivation and engagement, to stimulate collaborative learning and to model positive learning behaviors over time. Besides that, the possible *negative* effects of social media activities and internet use on face-to-face contact and psychological well-being may imply to address the issue of social media in education in a broader context.

These broader contexts will have to include aspects of social and mental health, like in-person social interaction, relationships with friends and family, and sports/exercise. Such an integral vision on educational concepts will have implications for research, for public policy, and for the design of technology.

6.3 Impact of new, upcoming technologies

In Silicon Valley, social media has already passed. The big developers have been working on the next ‘big things’ for some time. Those are: artificial intelligence, virtual reality, robotics, big data, and Internet of Things. So far, however, we could not find any studies or data about the possible consequences and implications of these new breakthrough technologies for the learning characteristics of future generations. Although it is difficult to predict exactly what will change, it is certain that the intensity, diversity and frequency of interactions between humans and highly sophisticated and intelligent support systems will substantially increase. What may await us are privacy hacks of gigantic proportions, which we cannot yet see. Global data fraud may involve countries and entire governments. From the business side we will learn a lot more about what may be termed 'surveillance capitalism' of Google, Facebook and Amazon, with increasingly sophisticated techniques. In this respect, things that are going to happen may become much bigger than *Cambridge Analytica,* substantially pervading many aspects of personal, educational and professional life. Of course, these kinds of developments may have an additional impact on the cognitive and social-psychological characteristics and skills of the young, thus generating questions like how do they have to deal with technologies with which control over people will be exercised? In the first place, this requires a higher degree of awareness concerning the characteristics, possibilities, and possible drawbacks of these technologies.

Whether the (possible) effects of technology have to be considered advantageous or detrimental depends on which evaluation criteria are used, i.e., which standards are chosen in order to determine what counts as relevant and as positive (or negative). Criteria and evaluation standards will ultimately depend on the global context, i.e., what is required for living (and surviving) in the future world. According to Harari (2018) the foreseen acceleration of change and uncertainty means that we have no idea about how the future world and job market will look like and what exact competences will be needed. He expects that continuous change will be the only certainty in the future careers of people. Future young people will, therefore, have to “re-invent” themselves for several times during their professional life. In Chapter 4, we have already postulated that the trend of increasing world-wide uncertainty may lie at the root of the ‘worry’ in most recent generations.
So, what do these youngsters then have to learn? Harari (2018) conjectures that modern education will have to provide at least two major overall capacities. First the permanent ability to learn new competencies, and second, the capacity to mentally cope with unknown and uncertain situations. These capacities are elements of *Individual Adaptability,* defined by Ployhart & Bliese (2006, p13) as “an individual ability, skill, disposition, willingness, and/or motivation to change or fit different task, social or environmental features”. This relates to the well-known 21th Century Skills, which also include 'Creativity', 'critical thinking', 'problem solving skills', and 'social and cultural skills' (Thijs, Fisser, & van der Hoeven, 2014; Voogt & Pareja Roblin, 2010).

Such skills are certainly not entirely new for military personnel, but with the introduction of sophisticated technologies and increasing uncertainty in the world they get a new dimension. This new dimension is further addressed in the next, and final, paragraph.

6.4 'Evolutionary mind and mismatch'

As has been briefly overviewed in Appendix 1, the modern world is facing various issues, such as global warming, lack of basic materials and natural resources, global financial crises, religious conflicts, propaganda and disinformation, economic inequality, and political dissatisfaction. In the mass media, as well as in social networks, these issues get the lion's share of attention relatively to the good news and the normal state of affairs (Rosling, 2018). Completely justified or not, the bulk of attention for these issues may generate an increasing amount of worry, stress and fear among the people about terrorism, refugees, mass migration, conflicts about natural resources, failed states, warfare, refugees, etcetera (Duchateau-Polkerman, 2016). Therefore, decreasing psychological well-being among the most recent young generation may be due to this increasing uncertainty in the world and has been found to be related to time spend on electronic communication and screens (reference).

However, with regard to mental health issue, there may be more at stake. In roughly 250,000 years evolution, homo sapiens has become supremely well adapted to survival in small close-knit nomadic groups working with primitive tools for food and shelter. But this is no longer the world we live in at this moment, and this will probably also be so in the future. The rapid advances of science and technology have radically altered our tribal circumstances, especially over the last few centuries (Buss, 2005; Harari, 2014). In addition, recent human societies consist of millions of people and the technologies we use today have effects across the whole planet, with the hangovers of global warming, mass destruction, and increasing inequality stretching far into the future. However, the evolution of human cognition did not keep up with this exponential pace of scientific and technological change.
Since biological evolution proceeds very slowly, it would take ten- to hundred-thousands of years to develop for us a brain that can cope with the psychological and moral problems our new powers create. So, after the rapid succession of three environmental revolutions (agriculture, industrial, digital) we still have a brain with basic characteristics and survival mechanisms that are specifically geared to living as hunter-gatherer in small close-knit groups (e.g. Buss, 2005; Giphart & van Vugt, 2016). This means that we now live in an environment that no longer 'matches' with the (psychological, physical, and behavioral) characteristics we have inherited from our ancestors.

So, if the environment of a species changes so rapidly that the brains and bodies of the individuals of the species do not fit well in the new environment evolutionary 'mismatch' occurs. In our present highly developed, technological ('civilized') world this mismatch can be clearly seen. Our brains are overstimulated by artificial and abstract information, under-stimulated by natural contexts, and misled (often deliberately, e.g. by advertising) by exaggerated, spurious, unimportant, and missing stimuli (Giphart & van Vugt, 2016). Mismatch may affect many important areas of modern life, such as: health care, work, mobility, immigration, sustainability, et cetera.

This may also count for mental health and psychological well-being of people. Despite our greatly increased (material) prosperity and medical care, we are still faced with growing problems in this area such as depression, burn-out, suicide, 'ADHD', addiction, (information) obesity, loneliness, anxiety, and xenophobia (e.g. Harari, 2017). Here, the ever-increasing pervasion of modern digital technology in the lives of our children may be a crucial determining factor.

If we incorporate more knowledge about the possibilities and limitations of our brain and evolutionary capacities and develop a vision about what is *really* good for us, i.e., what suits our intrinsic nature and potentials, then we can make better choices *in the long run*. We can then develop methods and techniques that better serve our evolutionary (psychological and physical) interests, improve our functioning and increase our long-term well-being. On the basis of such a vision, for example on what suits human's intrinsic nature and potentials, wise choices can be made concerning how to adapt education and training to the youngsters' changing skill- and mindsets. In this way it will be possible to address dilemma's like how to deal with the phenomenon of Snapshot Cognition and how to handle problems with reading long-form print or how to deal with decreasing in-person interaction. That is: should we *oppose* this short-cyclical and fragmented, thinking and learning, for example by designing curricula that include deep and focused critical thinking? Or should we, in contrast, conform more to these tendencies by fostering innovative ways of "snapshot education", i.e., more gaming, virtualization, screens, and electronic communication? Finding a wise solution in such dilemma's and how to optimally innovate the didactic design of learning curricula and training environments for the long-term requires more consideration and investigation, which will be partly carried out in the next phase of this project.

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A Megatrends 2030

Introduction

In this Appendix we will try to give an answer to the question what the world will look like in 2030 by describing (mega)trends. We define megatrends here as global, autonomous forces that affect all aspects of our lives and define the future of the world. The megatrends are categorized by the following domains: society, technology, economy, environment, or (geo)politics (STEEP). A STEEP analysis is an often-used framework to scan, analyze, and evaluate the impact of key driving forces or trends on a business or organization (e.g., Bradfield, Wright, Burt, Cairns, & Van Der Heijden, 2005). Societal trends capture demographics, religion, lifestyles, values. Technological trends include innovation, research & development, IT, transportation, automation, etc. Economy covers employment, consumer behavior, investments, and the like. Environment covers natural resources, pollution, climate change and their effects. Finally, Politics include voting behavior and political landscape, law and government actions, geopolitical developments, treaties and alliances, etc.

STEEP trends

There is an abundance of trend-reports describing the future of the world. Some of these aim to cover the breadth of the effects of developments in the aforementioned five STEEP domains of the world's future. More often, they aim to describe effects on a specific topic, such as the workforce in 2030. Our focus here is to synthesize some of the most rigorous reports in both categories to get an understanding of where the world seems to be heading at and what this means for the future Defense workforce. Specifically, we have used reports on megatrends of the big four accounting agencies (i.e., Deloitte, 2017; Ernst & Young, 2017; KPMG, 2014; PriceWaterhouseCooper, 2017), and Nesta, a global innovation foundation (Bakhshi, Downing, Osborne, & Schneider, 2017). We have chosen these reports because these agencies are internationally based, have sophisticated means or facilities for trend research, and deploy these activities as part of their services to customers, in both governments and virtually all sectors of economy. Our analysis is complemented with a tentative outlook on geopolitical developments, including military tasks, for which we used a trend report of the Dutch military (Ministerie van Defensie, 2010) and a report on megatrends by the US National Intelligence Council (National Intelligence Council, 2012).

Society

All trend reports agree that the world is expected to face an aging population, individualization[5] and urbanization. This has some important possible effects. First, the aging population may lead to scarcity of up-and-coming personnel and more competition for highly skilled talent, although some regions or nations will face saturated labor markets. The aging population may also lead to a higher pressure on the welfare and healthcare system.

[5] We define individualism in this report as *a social theory favoring freedom of action for individuals over collective or state control* (https://en.oxforddictionaries.com/definition/individualism).

Combined with individualism, this can go at the expense of social cohesion. People are expected to move towards cities. Estimations for citizens living in cities are around 50% in 2030 and 70% for 2050. This probably will increase the impact of disasters or climate catastrophes. The world may also face a concentration of wealth whereas at the same time — and as a result of globalization — extreme poverty is expected to go down. This development of increasing prosperity may create new middle classes who will demand their rights. Movements such as “black lives matter”, Occupy, European populist parties, and the empowerment of women are all suggested to evolve out of these emancipating new middle classes. Most trend reports refer to this process as individual empowerment. Scarcity of, and demand for, personnel may also empower individuals to demand greater work-private life balance. Recent generations, having grown up as Post Millennial with the transparency of the internet and social media, may demand for more transparency of employers and governments. It should be noted, however, that such global predictions have to be considered tentatively and carefully.

Technology

All reports mention the primacy of rapid advances in technological innovations as the major driver of global change (and thus of the other megatrends). At the same time they emphasize different aspects of this trend, like: new ICT developments, rise of human-like artificial intelligence (AI), and increased automation. This supremacy of technology is confirmed by other prognoses foreseeing an acceleration of technological breakthrough innovations. We may stand on the threshold of, what is often said, a new and critical era of human development (e.g. Bostrom, 2014; Harari, 2017, 2018.; Tegmark, 2017). According to these authors, the rapid upsurge and power of new, groundbreaking technology, such as gene-engineering, nanotechnology, data science, artificial Intelligence, and robotics, will have an undeniable, ever-increasing impact on every aspect of daily life[6]. Because of this dominant impact, the possible effects on cognition and learning of upcoming technologies, such as artificial intelligence, will be addressed more elaborately in Chapter 5.

Economy

The global economy becomes more and more interconnected. This will probably lead to economic interdependence, development, and reduced poverty of developing countries. Economic growth might decline in aging countries, such as The Netherlands. Trend reports also mention an increase of public debt which threatens government's ability to respond to social, economic and environmental challenges. This may create public and economic uncertainty which will also affect investment behavior (e.g., investing in solar power, etc.). On a smaller scale, people are expected to become more focused on and concerned about environmental consequences of their way of life. This may lead to increased collaborative consumption and an increased focus on people, nature, and planet relative to profit for business cases.

[6] Because of the pivotal and driving power of technological innovations, we will address this topic and its consequences more elaborately in Chapter 5.

Environment

All reports mention effects of climate change. The earth is expected to face more extreme weather conditions, rising sea levels, and water shortages. Pollution and climate change will lead to increased awareness of sustainability and motivation of individuals to protect it. Climate changes can lead to poverty as a direct result of economic costs associated with changing or extreme conditions (e.g., disasters or investments to ward off disaster). Climate changes can also have a more indirect effect on poverty through inequality within or between nations/regions that are differently affected by climate conditions as a result of varying demographics and public health. Moreover, since consequences of climate change are highly unpredictable and difficult to manage for less stable or prosperous nations or regions, effects of climate change will be felt most strongly in already poor societies. In the same vein, water and other forms of shortages of natural resources may lead to intra- or international conflicts, particularly where the effects have not been managed well in advance.

Politics

Dissatisfaction of citizens with the status quo (e.g., wealth disparity, mass migration, potential job losses) can lead to a rise in populism and ideology. In combination with disinformation and deep fake technology, this may lead to increasing difficulty to reach political agreements, and social and political stability in EU and Middle East, or even open doors for new regimes (dictatorship, popular parties, terrorist orgs). Effects of political uncertainty will be felt most strongly in the Defense sector, as well as other sectors that depend on investments or are exposed to uncertain government programs. On a geopolitical scale, trend reports expect a diffusion of power, such that power will shift to networks and coalitions in a world in which not one actor has absolute dominance over all others (i.e. multipolarity). Also, we will probably see a rebalancing of (economic) power in favor of upcoming markets. Stress on essential natural resources may lead to political conflict.

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11. AUTHOR(S)

Dr J.E. Korteling, Drs T. Hof, Drs M.H.E. 't Hart, Dr R. Wijn

12. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

TNO, P.O. Box 23, 3769 ZG Soesterberg, The Netherlands
Kampweg 55, Soesterberg, The Netherlands

13. SPONSORING AGENCY NAME(S) AND ADDRESS(ES)

K&I, Kromhoutkazerne MPC 55A, Postbus 90125, 3509 BB Utrecht

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15. ABSTRACT (MAXIMUM 200 WORDS (1044 BYTE))

Unpreceded societal and technological changes will probably affect cognitive and social-psychological characteristics of people, especially the young. For the Dutch Defense it is therefore useful to identify and understand the potential differing (work-related) characteristics of next generation(s) in order to develop and adopt cohort-appropriate education and training programs. The present literature study on this subject was carried out within the Defence research programme "*Education and (individual) Training (O&iT) in a dynamic operational context*" (2017 – 2021). The report starts with a description of the concept of generation. Subsequently the development of educationally-relevant characteristics over the last two decennia are portrayed and partly extrapolated to the future generation of students and young workers (2030). This is described from a cognitive- and a social-psychological perspective on training and education. In this endeavor we also analyze to what extent differences between generations are fundamental and 'hard' and with that, to what extent the concept of subsequent 'generations' is factually grounded. Next, possible effects of the most recent technologies, like social media and upcoming, groundbreaking technologies, such as robotics and artificial intelligence are addressed. Finally, some visions and concepts that may be most relevant for future learners in a highly technological society are provided and discussed. Based on the findings, in a next phase of this project, an educational approach (and guidelines) can be developed to (re)learn and enhance (or retain) the right motivation to do so.

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