We are our Habits: Mental Identity Conceptualized as Habits Moderated by Plasticity

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Abstract

While the parallels between habit and identity seem obvious, namely, mainly, that they both require consistency over time and that they are plastic, a theory that explicitly and systemically relates habit to identity has not yet been developed. The current essay is an initial reflection in this direction. It answers the question whether and how habit and, its complement, neuroplasticity can account for an innovative conception of identity. First it is shown that, within a person, psychological phenotypes and neurological make-up are inextricably intertwined, to, then demonstrate that the whole of these intertwinements within a person determines mental identity. Now, something has become integrated into identity if it is traceable to a certain point in the past, so that a singular deviating action is not part of one's identity. After a while, after having performed an act long enough, so that it has become etched in the neuronal system by a plastic process and, thus, has become habitual, it will also have become a part of mental identity. Logically, mental identity is the sum of all habits. Finally, considering this is merely an initial reflection, some difficulties are discussed.

Introduction

For a minute, before indulging ourselves into the following dry critique, think about who you are. How do you summarize yourself? You might start with some basic biological information like your sex or height or the colour of your skin. You might continue with some personal information like your name or occupation. Perhaps you consider some social aspects, like your political preference or your unbounded dedication to your Farmville clan. You might deem yourself kind, light-hearted and intelligent - because of some positive bias perchance - or you might deem yourself aggressive, depressed and uninterested. In any case, after a while, an idea of yourself is developed. Is this, then, your identity? However, what even is identity and, finally, does it make sense to subdivide it into different facets?

The earliest modern conception of personal identity is provided by John Locke (1632 - 1704) in *An Essay concerning Human Understanding* (1689/1847, p. 204-33). One of his main points is that the identity of the same man consists "in nothing but a participation of the same continued life, by constantly fleeting particles of matter, in succession, vitally united to the same organized body" (p. 208). The individual particles may be replaced, but the bodily organization remains the same. Locke concludes that your identity could never be mine, for I do not possess your physical body, nor could an exceptionally rational parrot ever be considered a man, for it would lack the necessary manlike material organization (Locke, 1689/1847, p. 209-10).

This conception of the 'same man', however, could never suitably define identity in its entirety, for one is more than merely organized matter. Therefore, Locke proposes a distinction between 'man' and 'person'. The latter he defines as "[…] a thinking intelligent being, that has reason and reflection, and can consider itself as itself […]" (Locke, 1689/1847, p. 210);

> For since consciousness always accompanies thinking and it is that which makes everyone to be what he calls self, and thereby distinguishes himself from all other thinking things; in this alone consists personal identity, i.e. the sameness of a rational being: and as far as this consciousness can be extended backwards to any past action or thought, so far reaches the identity of that person […]. (Locke, 1689/1847, p. 211)

In another more recent author, William James (1842 - 1910), comparable but not identical notions of identity are found. In *The Principles of Psychology*, James (1890, p. 650-9) notes that the empirical self is everything one calls 'me' and consists of the material self, the social

self, the spiritual self and the pure ego. The material self broadly includes one's physical possessions, such as the body, but also clothing or immediate family. These things, although they differ in degree of intimacy, all form part of

> the objects of instinctive preferences coupled with the most important practical interests of life. We all have a blind impulse to watch over our body, to deck it with clothing of an ornamental sort, to cherish parents, wife and babes, and to find ourselves a home of our own which we may live and 'improve' (James, 1890, p. 653)

The social self explains the "division of the man into several selves" (James, 1890, p. 656) in several social environments; man's identity changes with his social context. For example, the same person could be an elementary teacher by day and a metal vocalist by night. These differing social selves would be accompanied by different patterns of behaviour, thought and feeling. The spiritual self, the most enduring and intimate part of the self, is "a man's inner or subjective being, his psychic faculties or dispositions, taken concretely" (James, 1890, p. 659).

James' material self corresponds in some way with Locke's 'same man', for they both constitute our material aspects and, therefore, include the body. The spiritual self corresponds in some way to Locke's 'same person', for they constitute our psychological aspects; reason and reflection, in Locke (1689/1847, p. 210), and argue- and discriminability, i.a., in James (1890, p. 659). In addition, both authors state that the spiritual self or the 'same person' are our identity's most determining factors, for, in Locke, the identity of a person reaches as far back as the sameness of his rational being does, or, in other words and in James, "when these are altered is a man said to be *alienatus a se*" (James, 1890, p. 659).

The notion of identity as consistent rationality over time reminds one of two other interlinked subjects, namely habit and plasticity. Plasticity, as a general property of matter, is "the possession of a structure weak enough to yield to an influence, but strong enough not to yield all at once" (James, 1890, p. 105). Stone, because it is too strong, and mud, because it is too weak, are not plastic, while plastic, obviously, is. A plastic cup is malleable, but once moulded, an identical return to its initial configuration is impossible. James (1890), being a psychologist, refers specifically to plasticity of the nervous tissue. Our brain is plastic; it is able to adjust to influences, without completely succumbing to them all at once. A habit, then, is each "relatively stable phase of equilibrium in such a structure" (p. 105) of plasticity.

Habit and plasticity have been the subject of study for many contemporary authors (e.g., Carlisle, 2014; Malabou, 2019; Sloterdijk, 2014. For an overview see: Bell et al., 2013).

James' material conception of plasticity and habit is, maybe now more than ever, most relevant. The computer revolution of the 1960s, gave rise to the computational theory of mind (CTM) and transformed the psychological landscape. The CTM conceptualizes the mind as a computing system, like the Turing machine, so that our thoughts, feelings and actions are 'nothing but' biochemical processes (Rescorla, 2020). For example, before, when psychodynamic theory still dominated, depression was understood in terms of 'regression of the libido' or 'conflict of the ego' (Freud, 1917, 169-70). Today, however, depression is explained in great neurochemical detail. It is now related to decreased levels of monoamines in the brain, specifically norepinephrine, serotonin and dopamine (Goldberg et al., 2014).

While these findings have high empirical value, psychology has become more and more distant from philosophy's general concepts and phenomena. It is perhaps the same gap as between Locke's material 'man' and rational 'person'; a gap between two (neuro)psychological aspects, often seen and studied as separate. As Green and Wilker (1980, p. 121) concisely state: "Two sorts of personal identity criteria have been proposed. One concerns continuity and connectedness of personality, memory, and other mental phenomena; the other stresses spatio-temporal continuity of the physical body." James' habit and plasticity, however, combine these aspects, bridging the gap, for neuroplasticity refers to the material (i.e., nervous tissue), while habit refers to the phenotype (e.g., driving a car, brushing your teeth). In addition, the parallels between habit and identity seem obvious; they both relate to consistency in thought and behaviour, are self-perpetuating and plastic. However, a theory of identity that explicitly and systematically relates habit to identity has not yet been developed.

With this paper a first reflection in this direction will be made. It attempts to answer the following question: How can habit and neuroplasticity account for an innovative conception of identity? The current endeavour will thereby contribute to the unification of, what Catherine Malabou (2019, p. xv) aptly calls, "the space between biological and symbolic life". Biological life refers the "set of obscure data that resists consciousness" (2019, p. xv) and is advocated by reductionistic and material biology and neuroscience. Symbolic life refers to those dimensions of life that resist reduction to biological life and is advocated by phenotypical psychology and philosophy. Usually biological and symbolic life

are kept, and held to be, separate. However, habit and neuroplasticity have biological and symbolical relevance and could therefore function as a merger. The current study will also attempt to revitalize the Jamesian tradition by substantiating his claims with more recent neuropsychological findings. Let it be known that the current essay is not a manifesto for materialism nor phenomenology, yet an attempt to reconcile them, based on a conviction of their respective truths.

The structure of the essay is as follows. Firstly, substantiated by contemporary neurological evidence, it will be shown that neurological make-up and psychological phenotype (specifically pain processing) are inextricably intertwined. Secondly, in reference to the study of Phineas Gage, it will be shown that identity, which in essence is a psychological phenotype, also has its neurological substrates. Thirdly, it will be demonstrated that the brain not only changes by lesions, but also in positive and subtle ways, i.e., neuroplasticity. Fourthly, the relatedness between plasticity and habit will be presented. Also, habit's broad applicatory potential, namely as material, behavioural and mental, will be explored. In this sense, it will become apparent that habit is a bio-symbolical concept, lending itself to both aspects, enabling itself as a merger between them. Lastly, building on this capacity, it will be shown that mental identity can be conceptualized as the sum of all habits.

From neuron to psychological phenotype

To begin, if the argument that habit and neuroplasticity account for identity will be developed, another fundamental premise should be proposed. Surely, if neuronal make-up would not have anything to do with the way we behave, think or feel, then how could neuroplasticity possibly account for identity? Therefore, it should be proposed that our conations, cognitions and affections, or, together, our psychological phenotypes are causally related to neuronal make-up. This, of course, is barely proof and, therefore, in what follows, it will be shown that contemporary neurological evidence is in line with this proposition.

Many relations between reductive neurological and phenotypical psychological phenomena have been found. Lesion studies are (one of) the most important sources of data for neurologists. In these studies, patients with neuronal damage and corresponding phenotypical impairments are compared. Specific neurological deficiencies always lead to specific and often absurd psychological impairments and it is therefore that psychological functions of specific brain areas can be deduced. To illustrate, two ground-breaking, often

cited and replicated (Girard-Tremblay et al., 2014; Mancini et al., 2019; Ogino et al., 2007; Wood et al., 2020) studies on parallel pain processing will be presented.

Ploner et al. (1999) examined a patient with a lesion in the right primary and secondary sensory cortices. In their study, the patient's arms were painfully stimulated with a laser. Pain localization and pain affect were subjectively measured. The right arm functioned normally; the patient was able to almost exactly localize the stimuli. However, when the left arm was painfully stimulated, "the patient spontaneously described a 'clearly unpleasant' intensity dependent feeling emerging from an ill-localized and extended area 'somewhere between fingertips and shoulder', that he wanted to avoid" (Ploner et al., 1999, p. 213). So, while the right arm functioned normally, pain localization, but not pain affect, was impaired in the patient's left arm. This study demonstrates a specific role of the sensory cortices in the sensory-discriminative, but not affective, aspects of pain perception in humans (Ploner et al., 1999). A second study (Rainville et al., 1997), using functional *Magnetic Resonance Imaging* (fMRI), a method of measuring brain activity, attempted to locate affective pain processing in the brain. The authors, using hypnosis, were able to reduce the subjective unpleasantness of pain. This reduction was associated with differential Anterior Cingulate Cortex (ACC) activity, while activations in the sensory cortices were comparable. The study, therefore, shows that the ACC plays a prominent role in encoding the affective, but not the sensory-discriminative, dimension of pain (Rainville et al., 1997).

Together, these two studies show how neurologists are able to deduce psychological functions of specific brain areas, namely by relating neurological alterations (through lesion or experimental manipulation) to psychological alterations or vice versa. This, in turn, demonstrates that our phenotypical psychology and our neurological make-up are causally intertwined. That is, specific neuronal alterations (such as a lesion) always lead to quite absolute and specific impairments and the same lesion always leads to the same impairment. Lesions in the sensory cortices, for example, always lead to impairments in pain localization, but never to impairments in pain affect (of which the ACC is responsible; Rainville et al., 1997). Now, critically, this does not necessarily mean that the same cortical activity always leads to the same psychological phenotype between persons. For example, while the visual cortex is active during tactile perception in the normally sighted (Prather et al., 2004), research on neuroplasticity has demonstrated altered visual cortical activity in the early- and late-blind during tactile perception (Sathian, 2005). Thus, because of 'environmental effects' (such as acquired blindness) and neuroplasticity, neuronal anatomy and physiology might

change significantly within a person. However, this only serves the current point. Namely, research has also shown that the blind possess superior tactile perception and that this is related to increased visual cortex activity during tactile perception (Sathian & Stilla, 2010). So, arguably, in the neuroplastic adaptation to the 'environmental effect' of blindness, tactile perception is improved to compensate for the acquired blindness by recruiting the obsolete visual cortex for tactile perception (Sathian & Stilla, 2010). In this case, again, the brain has changed and, with it, the psychological phenotype. It is therefore that the following premise can be laid down: within a person, phenotypical psychological aspects and neurological make-up are inextricably intertwined. Simply put, when the brain changes, so do our thoughts, feelings and behaviours[1]. What exactly changes, is decided by the magnitude and exact location of the neuronal alteration. Because, aside from lesions, developmental issues, natural variations et cetera, brain architecture is mostly similar between people, phenotypical impairments will also be broadly similar.

From neuron to identity

In another often cited, elaborated on (Damsio et al., 1994; Ratiu et al., 2014; Solms, 2002) and corroborated (for a recent review of the evidence see: Yu et al., 2020) historical patient study (Harlow, 1868/1993), the relation between neurological make-up and identity becomes more obviously apparent. Phineas Gage was "a perfectly healthy, strong and active young man", (Harlow, 1868/1993, p. 275) until, in a tragic railroad work accident, he got his skull and brain penetrated by an iron rod, passing completely through his head. Amazingly, Gage was back on his feet already later that day. Sadly, however, he would never be the same.

> His contractors, who regarded him as the most efficient and capable foreman in their employ previous to his injury, considered the change in his mind so marked that they could not give him back his place. The equilibrium or balance, so to speak, between his intellectual faculties and animal propensities seemed to have been destroyed. He proved to be fitful, irreverent, indulging at times in the grossest profanity (which was not previously his custom), manifesting but little deference for his fellows, impatient of restraint or advice conflicting with his desires, at times pertinaciously obstinate, yet capricious and vacillating, devising many plans of future operation, which were no

[1] As will be shown later, the inverse is also true.

> sooner arranged than they were abandoned in turn for others appearing more feasible. A child in his intellectual capacity and manifestations, Phineas Gage had the animal passions of a strong man. Previous to his injury, though untrained in the schools, he possessed a well-balanced mind, and was looked upon by those who knew him as a shrewd, smart business man, very energetic and persistent in executing all his plans of operation. In this regard his mind was radically changed, so decidedly in fact, that his friends and acquaintances said he was 'no longer Gage'. (Harlow, 1868/1993, p. 277)

In a Jamesian as well as in a Lockian sense, Gage's identity had changed. As said before, Locke (1689/1847) proposes a two-sided definition of identity, namely as "constantly fleeting particles of matter […] united to the same organized body" (p. 208), on the one hand and "the sameness of a rational being" (p. 211) on the other. In both senses, Gage's identity had changed. His material organization, quite obviously, was altered because of the physical lesion. However, his rationality, as proven by the observation that he was "no longer Gage" (Harlow, 1868/1993, p. 277), was also changed. So, his mental being was affected by the purely physical lesion. In a Jamesian sense too, Gage's identity, his "inner or subjective being, his psychic faculties or dispositions, taken concretely" (James, 1890, p. 659), or spiritual ego, was altered and it is thus, James would proclaim, that Gage was "*alientatus a se*" (1890, p. 659). The penetration of Gage's skull and brain by the iron rod is a purely physical event, yet its effects are both physical and mental. This illustrates the necessary intertwinement of the brain and identity.

Not only modern philosophy, but also contemporary neuroscience reflects on this relation, often with Gage as an example. Recently, Mark Solms, fittingly known for his integrative approach to psychoanalysis and neuroscience (Solms, 2000), notes the indisputable inextricability between the brain and the mind.

> In our clinical work as neuropsychologists we have met hundreds of Phineas Gages, all with damage to the same part of the brain. This is a fact of obvious importance for anyone with an interest in personality. It suggests that there is a predictable relationship between specific brain events and specific aspects of who we are. If any one of us were to suffer the same lesion in that specific area, we would be changed in much the same way Gage was, and we, too, would no longer be our former selves. This is the basis of our view that anyone with a serious interest in the inner life of the mind should also be interested in the brain and vice versa. (Solms, 2002, p. 4)

Now, all this is not to say that the iron rod hit Gage right in the identity, for there is no evidence for - nor would it suffice conceptually to propose - a centralized identity cortex in the same way the sensory or visual cortices are described. The latter are defined by their functionality; the sensory and visual cortices activate when processing sensory and visual information, respectively. But according to James, spiritual identity is all psychic faculties and, since all psychic faculties (e.g., language, calculation, visual processing, etc.) are distributed throughout the cerebral cortex, the entire cortex would thus, oddly, be the identity cortex. In addition, when taking James's "subjective being […] or dispositions" in a broader (but still appropriate) sense, sub-cortical areas such as the nucleus accumbens or the amygdala, respectively associated with reward (Carlezon Jr & Thomas, 2009) and fear (Tottenham, 2010) processing, should also be included in the identity network. Damage to this network should, then, always results in an altered identity.

However, we do not necessarily speak of an altered identity in, for example, the case of a lesion in the previously mentioned sensory cortices (Ploner et al., 1999), but we do speak of this in the case of Gage. In this regard, it could be argued that the part of Gage's brain that was struck by the rod might be more socially relevant and therefore more apparent for people surrounding Gage. As Damasio et al. (1994) showed in a re-examination of Gage's skull, the lesion did not involve language and motor related areas, in line with Gage's ability to speak and move as before the accident, but did include the ventromedial region of both frontal lobes (vmPFC). Damasio et al. (1994, p. 1104) note that in patients with this neuroanatomical pattern "their ability to make rational decisions in personal and social matters is invariably compromised and so is their processing of emotion." Logic, calculation and knowledge recollection, however, remain intact (Damasio et al., 1994). Perhaps, because of the social relevance of the vmPFC, phenotypical impairments are more apparent for people surrounding patients with lesions in this region, rather than for patients with lesions in, for example, the sensory cortices. The same goes for Gage; because of his specific lesion, his rational decision-making in social situation was impaired and his friends and family discerned him "no longer Gage" (Harlow, 1868/1993, p. 277). Thus, it is not necessarily the case that Gage's identity was altered and Ploner et al.'s (1999) patient's identity remained intact. Rather, in both cases there were certain psychological impairments and therefore, since identity pertains "all psychic faculties" (James, 1890, p. 659), altered identities. This makes common sense too; when describing persons, is their inability to feel pain not a relevant aspect of their being?

With the appropriate modesty and restraint, it could be stated that identity is determined by the totality of psychological phenotypes and neurological make-up, which are in any case inextricably intertwined. However, two critical reflections should be delineated. Firstly, identity, aside from the mental phenomena of conations, cognitions and affections, should probably also involve some physical aspects, such as height, skin-color or, perhaps, a missing finger or ear. This is what Locke refers to when he speaks of the 'same man' and what James describes as the material self. Obviously, these aspects are also highly relevant in describing a person and cannot be neglected. Secondly, to say that something is determined, is dangerous. However, James calls the self 'empirical' for a reason; it is everything one is tempted to call 'me', based on observation. So, it is the totality of someone, as observed by him- or herself. In this sense, the idea of self is a result or a consequence of observed facts; first someone exists and then he or she formulates a corresponding identity[2]. Accordingly, if the agent changes and this change is observed, then his or her identity is also altered. In this conceptualization, however, it would be illogical to propose that first identity (the whole) changes and, then, the underlying specific aspect. Mathematically, one plus two equals three and if the two becomes a three, then the sum becomes a four. It would be quite absurd to imagine that, first, while the addends are still one and two, the sum spontaneously transforms into a four, so that, consequently, the two becomes a three. All this is to say that identity, the whole, is a consequence of its constituents (and not the other way around) and is therefore determined by these. Based on these critical notions, confidently, it could be stated that: *mental* identity is determined by the totality of psychological phenotypes and neurological make-up, which are inextricably intertwined.

Lastly, Macmillan and Lena (2010) note that Gage, some years after the accident, made a reasonably good social recovery and that, therefore, he was not "no longer Gage". This, arguably, is incorrect. Namely, Gage did not entirely recover, i.e. there is a discrepancy between the neuronal equilibria of 'pre-accident Gage' and 'post-recovery Gage' and are therefore different identities. While this may be less of a problem, another problem arises when 'recovering Gage' is considered. Because recovery is an ongoing process of change, there is a relative neuronal disequilibrium in 'recovering Gage'. Still Gage, based on an instable neuronal make-up, is *identified* as 'recovering'. So, inconsistency can also inform

[2]N.B., the current author is convinced that self-observation, or any consciousness at all, is not necessary for an (altered) identity. Everyone has an identity, whether they like it or not, just like a blind person still has an outer appearance, even if the entire world was blind. Objects such as fruits, for instance, also have identities; apples and oranges were never the same. Not even before humans or animals distinguished between them.

identity, in contrast to Locke's definition of identity, which we hold so dearly. In defense, 'recovering Gage' can fittingly be *identified* as 'recovering from brain trauma', because there is traceable consistency in this aspect of his (neuronal) being. He is constantly recovering; there is consistent inconsistency; his altering identity has become a part of his identity. So, interestingly, it seems that neuroplasticity is not only relevant in changing identity, but also in becoming identity. Finally, since 'neuroplasticity' is conceptually subordinate to neuronal make-up (i.e., is a part of it), the identity of 'recovering Gage' still follows from his (altering) neuronal make-up.

Plasticity and habit

Up to this point, the relation between the brain and identity has only been examined in terms of physical neuronal damage. According to a recent study by Adrian Johnston and Catherine Malabou (2013), neuronal damage, although less obviously, may "be said to be plastic in the sense that it forms and sculpts a new identity. When brain damage occurs, it interrupts the economy of our affects." (p. 58). Besides this negative plastic power, however, there is a second positive plastic power, which "characterizes the formation process of neural connections and the fact that these connections may be transformed during our lifetimes and the influence of experience and of the kind of life we are leading" (Johnston & Malabou, 2013, p. 56). Johnston here refers to what in neuropsychology is called neurogenesis, synaptogenesis and myelination; respectively, the formation of new neurons, new synapses and myelin sheath (i.e., a fatty neuron isolation, resulting in quicker neural transmission). Additionally, however, not only are new neural pathways created; older unused pathways are removed or, 'pruned' (Santos & Noggle, 2011). These four neural phenomena comprise structural neuroplasticity. Plasticity happens throughout the lifespan, but explodes in puberty (Spear, 2013). Also, although the literature is clearer on the existence of plasticity in some areas than others (e.g., the olfactory bulb; Zhao et al., 2008), there is evidence for structural plasticity throughout the entire brain, including the cerebral cortex (Rakic, 2002); the site of the highest cognitive functions. Thus is the *biological life* of neuronal plasticity.

Philosophically, or *symbolically*, a lot has been said about (neural) plasticity. James, in chapter four of *The Principles of Psychology*, entitled *On Habit*, is one of the first to speak of plasticity and has, since then, been a cornerstone in the plasticity literature. In James, plasticity is a property of constellations of matter in general. Broadly, it means "the

possession of a structure weak enough to yield, but strong enough not to yield all at once" (James, 1890, p. 105). Now, James notes the inextricable relation it has with habit: "Each relatively stable phase of equilibrium in such a structure is marked by what we may call a new set of habits" (James, 1890, p. 105). Thus, habit and plasticity are complementary; a structure in equilibrium implies habit, a structure in disequilibrium implies a plastic process. Yet, neuroplasticity enables the formation of new habits and the elimination of old ones. Note, here, that 'habit' does not necessarily entail human phenotypes; in James, habit is broader. As will be shown later, even a flow of water or a forest path are plastic structures and can be described in terms of habit. James (1890), however, being a psychologist, does apply habit and plasticity to living beings, about which he remarks that:

> Organic matter, especially nervous tissue, seems endowed with a very extraordinary degree of plasticity of this sort; so that we may without hesitation lay down as our first proposition the following, that the phenomena of habit in living beings are due to the plasticity[…] of the organic materials of which their bodies are composed. (p. 105)

Habit, as initially postulated by Leon Dumont (1876), is self-perpetuating. He notes that, just like water buries, merely by flowing, a wider and deeper canal, returning in its traces even after having stopped for a while, just so the external impressions on the nervous system shape for themselves more and more appropriate paths (Dumont, 1876, p. 324). For example, a smoking habit is not developed after a single drag, but each drag makes such a development more and more likely. Building on this metaphor, it is still easy to imagine how, when a stream of water is dammed off, it redirects, starting shallowly and less distinct, but becoming more and more nuanced over time. Just so it is in the nervous system. When, for some reason, a man alters his habits, the beginning is difficult, for the appropriate neural pathways are 'shallow and less distinct', but it becomes easier over time. Thus, when new behaviours are consistently performed, the brain, through plasticity, forms itself accordingly and the behaviours become habitual. Fittingly, James (1890) notes that "habit simplifies the movements required to achieve a given result, makes them more accurate and diminishes fatigue" (p. 112) and that "habit diminishes the conscious attention with which our acts are performed" (p. 114). Later, it will be substantiated that this phenomenon is not limited to mere behaviour, but extends to all aspects of human mind and matter.

Besides the canal, another enriching metaphor is proposed by the contemporary Claire Carlisle (2014, p. 23), namely the forest path. A pathway, on the one hand, facilitates an

easier traversing of the forest and, on the other, inclines one to take that route. Surely, it is both more difficult and sillier to attempt to traverse heavy forestation, say, right beside the path. Just so with habits; they simplify the movements and encourage their particular behaviours. In addition, the formation and maintenance of habit is also encapsulated in the metaphor of the pathway. Traversing a pathless forest for the first time is difficult and will still be difficult for the second and third time. When the same route is taken, however, the fourth and fifth time will become easier and easier. By contrast, if habits are not acted out, they will disappear: "pathways endure through the periods between these movements, although they will disappear if they fall out of use for too long" (Carlisle, 2014, p. 23). This duality is often referred to as the 'double law' of habit, originally familiarized by Felix Ravaisson in his *De l'habitude* (1838/2008, p. 94-5), and sates that "the continuity or the repetition of passion weakens it; the continuity or repetition of action exalts and strengthens it. Prolonged or repeated sensation diminishes gradually and eventually fades away. Prolonged or repeated movement becomes gradually easier, quicker and more assured." Carlisle (2014, p. 31) critically notes that, because of this duplicity, a habit can be both a vice and a virtue: "Because actions are strengthened by repetition, habit increases the efficiency and accuracy of our movements - but this same strengthening can be a problem if we want to change habits that have become deeply entrenched." Lastly, Malabou (2008) notes that:

> With plasticity we are dealing with a concept that is not contradictory but graduated, because the very plasticity of its meaning situates it at the extremes of a formal necessity (the irreversible character of formation: determination) and of a remobilization of form (the capacity to form oneself otherwise, to displace, even to nullify determination: freedom). (p. 17)

Habit as bio-symbolical concept

At present, the concept of habit has many interpretations (for all following definitions: Merriam-Webster, n.d.). Probably the most used application is that of the behavioural habit, which is "a settled tendency or usual manner of behaviour". For example, the habit of taking a morning walk or smoking cigarettes.[3] Less obviously, habits can also be mental, namely as

[3] With these examples it becomes clear that different habits can have different intervals; the habit of smoking might manifest itself hourly, while, surely, the habits of taking a morning walk and celebrating Christmas only manifest themselves daily and yearly, respectively.

“the prevailing disposition or character of a person's thoughts and feelings”. For example, many philosophers might be relatively inclined to overanalyse everyday occurrences; thus philosophising in a habitual manner. Still differently, habit can refer to “bodily appearance or makeup”. In this sense, the “characteristic mode of growth or occurrence” of an organism like corn (or, perhaps, the nervous system) can be described. It seems that habit is a very broad concept with many applications. However, all of these applications converge on one aspect. In the definitions above, a behavioural habit is only ‘usual’, a mental habit but a ‘disposition’ and a physical habit merely ‘characteristic’. For example, it is hard to quit a smoking habit, yet not impossible; it is difficult for Socrates to conduct himself as a satisfied fool, but not impossible, and lastly; that the Tehua corn plant typically does not exceed six meters in height (Wellhausen et al., 1952, p. 105), does not exclude a ten meters high plant of this variety (Karl, 2013, p. 2-3). Thus, the many nuances of habit all rely on a broader and more general principle. Namely they all imply a tendency, but not a necessity.

Habit (and, since they are complementary, also plasticity) could be helpful to explore the gap between the biological and the symbolical. As seen in James (see above: ‘Plasticity and habit’), but also in contemporary definitions, habit can easily be applied to matter. In James, plasticity is a property of constellations of matter and habits are the relatively stable phases in such a material plastic structure (James, 1890, p. 105). Biologically or materially, the brain is a plastic structure and its stability can therefore be described as a habit. For example, at present, the reader’s brain might be relatively stable, since it (dependent on the reader’s judgement of this essay so far) is not affected by great impressions, especially when juxtaposed with events like the penetration of the skull by an iron rod (which, indeed, albeit external, is an impression). In the latter case, the material brain is significantly altered and, therefore, involved in a plastic process of the negative kind (Johnston & Malabou, 2013, p. 58). Following the accident, the brain regenerates and is thus involved in another plastic process of the positive kind (Johnston & Malabou, 2013, p. 56). The brain attempts to repair itself and might partly succeed in doing so, but can never return to its initial state, just like a wrinkled plastic cup. Now, the current reader’s brain, in its relatively stable state, could be scanned and presented using fMRI or other neuroimaging technologies. What results, in essence, is a representation of the reader’s current material habit. Surely, this way of putting things is barely adequate for describing personality, intelligence and the like, since symbolical life is per definition irreducible to biological life (Malabou, 2019, p. xv). Still, the point is clear that a stable neuronal pattern could be described as habitual. In this sense, it is

suggested that habit applies to biological life, namely as one's current relatively stable neuronal make-up.

James already perceived the bio-symbolical meaning of habit. He not only states that the simplest of habits, mechanically (or *biologically*), are neuronal discharges with a corresponding material habit (in the sense described above), but also that this is the case with more complex habits. As he states this himself:

> For, of course, a simple habit, like every other nervous event - the habit of snuffling, for example, or of putting one's hands into one's pockets, or of biting one's nails - is, mechanically, nothing but a reflex discharge; and its anatomical substratum must be a path in the system. The most complex habits, as we shall presently see more fully, are, from the same point of view, nothing but *concatenated* discharges in the nerve-centres, due to the presence there of systems of reflex paths, so organized as to wake each other up successively - the impression produced by one muscular contraction serving as a stimulus to provoke the next, until a final impression inhibits the process and closes the chain. (James, 1890, p. 226)

Thus, not only simple, but also more complex habits are attributable to simple neuronal discharges. Now, in the above excerpt, James' examples of complex habits are still behavioural habits. James gives "the keyboard near the hand" (1890, p. 237) as an example of an initial impulse. The sensation of the initial impulse leads to a certain reflexive action like pressing a key. The resulting sensations next lead to new reflexive actions, and so on and so forth, until the entire piece is performed. Neurologically, a chain of discharges led to the agent playing the complex piece. Thus, the only difference between a simple action and such a complex action is quantitative, but not qualitative; both are traceable to simple discharges, but a cumulation of these discharges is implied in the latter. However, because habit can refer to cognition in addition to matter and behaviour (Merriam-Webster, n.d.), it would be sensible to evaluate thought or feeling in this regard as well. Habits of thought might be even more complex and even less concrete than habitual actions. Yet, it is not insensible to assume that the same principles apply, since both are human phenotypes. That is, does the habit of overanalysing, just like any behavioural habit, not also require a relevant anatomical fundament; an existent neuronal path? Also, is overanalysing not essentially an action as well? Surely, it is not a behavioural action, for there is no corresponding behavioural consequence, but it is an action nonetheless; something that is performed. If James' logic is

applied, cognitive and conative habits would not differ qualitatively, but quantitatively; they are both constituted by neuronal discharges. As implied by their degree of complexity, habits of thought would require numerous neurons organized in intricate constellations, but the principle would be the same. An acquired cognitive habit should always exist in a certain constellation of (physical) nervous tissue. Lastly, contemporary neuroscience informs us about the relevance of location of neuronal activation. Habitual thought and behaviour thusly also probably differ in their respective locations in the brain.

Identity as habit

Thus, habit is biological as well as symbolical. It may be used to describe stability in plastic material structures, thereby applying it to biological life. It is also used to describe usual or likely patterns of behaviour, thought or feeling, thereby applying it to symbolical life. But, by Malabou's (2019, p. xv) definition, symbolical life could never be reduced to biological life and this is surely not the current point. However, firstly, biological life and symbolical life are connected, as proven by many of the above (Ploner et al., 1999; Phineas Gage) and, secondly, habit is situated in between these two conceptual extremes. Now, a similar bifurcation is found in all previously discussed notions of identity (Green & Wilker, 1980, p. 121). Personal identity has always consisted, on the one hand, of continuity and connectedness of personality, memory, and other mental phenomena. In Locke this is the 'same person' and in James the 'spiritual self'. On the other hand, personal identity has always *also* consisted of spatio-temporal continuity of the physical body. This is Locke's 'same man' and James' 'material self'. The keen reader might note the symbolical and biological character of the former and the latter, respectively. Mental phenomena are symbolical, while the physical body is biological. The even keener reader might note the relevance of habit in this regard. Namely, as seen in the above, habit is situated in between the biological and the symbolical. Also, habit and identity are analogously characterized by continuity. On the basis of this, an attempt will be made to explore the relations between habit, plasticity and identity in what follows.

Identity, as seen in Locke, is "the sameness of a rational being: and as far as this consciousness can be extended backwards to any past action or thought, so far reaches the identity of that person". (Locke, 1689/1847, p. 211). Notably, this conception of identity implies consistency. If one's rational being is no longer the same, then one's identity has

changed. Now, as seen in James and Dumont, the changing of one's rational being always leads to some anatomical alteration and vice versa; physical plastic processes (either negative plastic power, such as lesion, or positive plastic power, such as neuro- or synaptogenesis) always lead to altered rational beings. An altered identity would, then, also always imply an altered organization of nervous tissue. So, if identity truly is subjugated to the plastic structure of the nervous system and habit is stability in plastic structures, then the 'sameness of a rational being' is habit and one's current identity is nothing more than one's habits, developed by repeated action and a corresponding neuroplastic process.

To elaborate, habit is a relatively stable material state in a plastic structure (James, 1890, p. 105). It is, thus, absolutely correct to describe one's relatively stable neurological makeup at a certain point in time as habitual. This relates to Locke's conception of the 'same man' where identity consists "in nothing but a participation of the same continued life […] vitally united to the same organized body" (1689/1847, p. 208). Now, as seen before, one's mental identity is determined by the totality of one's inextricable psychological phenotypes and neurological make-up (see: from neuron to identity) and identity requires consistency in that it has to be traceable back to an earlier point in time. If a material constellation of neurons, a neuronal path, is traceable back for, say, half a year, has it not been stable in that time and thus habitual? So, the material aspect of one's identity can be equated with habit, so that anyone's material identity is the same as one's material habit. Surely, if one of the countless neuronal paths (habits) is altered, it is not the entire identity that is altered; perhaps only a small part is added or removed. Changes vary in their degree; just like a very minor aneurysm inflicts less of an alteration than an iron rod through the brain.[4]

The same logic applies to the immaterial. (As seen, habit surely does not only apply to material.) Single behaviours are not plastic per se, just like single particles of matter are not. However, over time, patterns or structures of behaviours are formed and it is these that are plastic. They are formable, but also resisting and self-perpetuating. Conative habits, then, are relatively stable patterns of behaviour in the plastic structure of behaviours. For example, a person might smoke a cigarette right after waking up, before and after meals and before going to sleep. This is a more or less stable behavioural, and thus habitual, pattern. Another person,

[4] Death is, perhaps, the ultimate example of an altered identity; there are no neuronal activations and, correspondingly, no psychological phenotypes. There still is an identity. In death, two things happen: (1) the attribute of death is integrated into the person's identity and (2) the identity becomes an history; a 'was' instead of an 'is'. Someone *is* dead and *was* kind, for example. The former is reflected by neuronal inactivity and the latter is reflected by neural remnants, but as these remnants fade, so does the identity.

however, does not possess such a behavioural pattern, but surely does possess others, such as drinking a glass of lemon juice right after waking up. Also, that the latter person does not habitually smoke, does not mean he could never develop such a habit; some potentiality is implied. In this sense, patterns of behaviour are plastic and a stable pattern implies a habit. Here, a parallel with identity is found. Since, for certain manners of behaviour to become identity, the behaviour has to be consistently repeated over a certain time; smoking once or twice surely does not make someone a smoker. It is only when the smoking is regularly performed, when smoking has become a relatively stable pattern of behaviour (a habit), that one has become a smoker. Thus, once certain patterns of behaviour have become stable over time and etched in the brain by a neuroplastic process (i.e., habitual), they become a part of one's mental identity. Mental identity can, thus, be described in terms of habits, where one's identity is the sum of all his habits. Some habits are more defining than others, but all habits are significant; some habits might explain five percent of one's identity, while others a mere 0.01, but eventually, after summating all habits, one hundred percent of one's consistent traceable conations, cognitions and affections are captured and thereby one's mental identity.

But thoughts and feelings are also a part of one's identity. This was already seen in Locke's 'same person' and James' 'spiritual self', but makes common sense too. Would an appropriate description of oneself not contain some notions on one's psychic faculties? Are thoughtful, critical and loving, but also, short-sighted, stubborn and melancholic not apt descriptions of someone's mental identity? (However, probably, this specific collection of terms would not suffice as an adequate description of one's entire identity. The latter requires an exhaustive list, once again, of a person's relevant faculties. In such a list, increased detail is always appreciated, but also leads to obscurity; the least relevant aspect of one's identity is still relevant, yet probably unknown. Especially negative qualities are generally overseen. This, however is beside the point, since the goal is to conceptualize identity and not to guide the reader in uncovering its own.) In theory, concepts such as 'thoughtful' or 'melancholic' could be used to describe one's identity. When, however, is one said to be thoughtful or melancholic? Surely not after a single contemplative or depressed episode, respectively, and perhaps also not after a second. However, after certain manners of thought or feeling are consistently presented, they self-perpetuate and become habitual, just as was seen with behaviour. It is then, when relative equilibria in the plastic structures of thought or feeling have manifested, when certain cognitive or affective habits have developed, that one is said to be thoughtful, melancholic or the like; as a part of one's identity.

Identity, as it is currently conceptualized, is independent of social judgement. A certain scientific realism is striven for, namely that identity exists outside of our judgement. Whatever names or categories humans may give certain apparent characteristics, the identity remains the same. As was seen in one of the footnotes above, apples and oranges were always different, even before humans or animals could distinguish them. In fact, their fundamental differences are precisely the reason for humans and animals to distinguish between them and give them different names. Yet, fundamentally, the apple nor the orange changed in its material configuration, nor its phenotype, after being thus named. Likewise with mental identity: although a virtuous person in this world might be considered evil in a world of saints and Usain Bolt might be considered sluggish in a world with entities with twice the running speed, the virtuous person nor Bolt would change in its material configuration, including their neuronal make-up. Neuronal make-up and psychological phenotypes are inextricably intertwined and their totalities form identity. Therefore, their identities would also remain the same, even though their social surroundings might discern them otherwise.

So mental identity is habit: materialistic as well as phenotypical, or; biologically as well as symbolically. Biologically, any material identity could be described in terms of its material habits, albeit those of the nervous system or the body in general. Symbolically, any phenotypical identity could be described in terms of its corresponding conative, cognitive and affective habits. Habit thus explains not only *that*, but also *how*, our neurological make-up is related to psychological phenotype, including identity. Namely, when one's neurological make-up is relatively stable (habitual), one's phenotype is as well. When, however, one's neurological make-up changes by a plastic process triggered by some external or internal impression, the person changes as well; biologically and symbolically. When, then, this neurological mutation halts and reaches, what James denotes as an 'equilibrium', a new set of habits is achieved and an identity altered. Logically, identity is plastic.

Discussion

Based on an observation of the parallels between conceptions of identity and habit, as an initial reflection, the current essay attempted to reconcile the two; to explain identity in terms of habit. It attempted to answer the following research question: How can habit and neuroplasticity account for an innovative conception of identity? Firstly, substantiated by contemporary neurological evidence, it was shown that neurological make-up and

psychological phenotype (specifically pain processing) are inextricably intertwined and that damage to a certain part of the brain always leads to more or less the same corresponding psychological impairment. Secondly, in reference to the study of Phineas Gage, it was demonstrated that identity, which in essence is a psychological phenotype, also has its neurological substrates. Thirdly, it was shown that the brain not only changes by lesions, but also in positive and subtle ways. The brain is able to change in meaningful ways on account of its neuroplasticity. Fourthly, the relation between plasticity and habit was presented and, herein, habit's broad applicatory potential, namely as material, behavioural or mental, became apparent. In this sense, habit was conceptualized as bio-symbolical, lending itself to both aspects, enabling itself as a merger between them. Lastly, utilising this capacity, it was argued that habit and plasticity could be used as an innovative conception of identity. A theory that explicitly and systemically relates habit to identity had not yet been developed. Accordingly, the current essay contributes to the endeavour to bridge the gap between the biological and the symbolical, two aspects of life, often held and studied to be separate.

The main point should be more extensively summarized. Identity requires consistency over time; a single act is never an indication of one's identity, but multiple consistent performances of the same act are, albeit conative, cognitive or affective. In order to distinguish between identity related action and non-identity related action, the notion of habit is crucial: an action is in harmony with one's identity once it has become habitual. Therefore, in essence, identity has become a summation of all habits and a person's concrete identity, a list of all its conative, cognitive and affective habits. Surely, this is often temporary; a certain identity does not guarantee certain action, it merely makes it more probable. People sometimes act in incongruence with their identity, while their identity remains the same. It is only when these actions become consistent and habitual that identity is altered. 'Habitual', here, refers to biological life as well as symbolic life; a distinction familiarized by Malabou (2019, p. xv). Biological life is everything material, such as the nervous system. Symbolic life is everything irreducible to biological life, such as smoking or the feeling of love. Thus, concretely, an action has become a habit when and only when it has become (1. symbolic) 'a usual or likely pattern of behaviour, thought or feeling' and (2. biological) 'rooted in the nervous system by a plastic process'. When any action is or has become habitual, it is or has become a part of identity. Such is the bio-symbolical application of habit and its relation to identity. Lastly, the relation between biological and symbolical habit is codetermining. It can never be the case that a biological habit exists in the nervous system without any symbolic

counterpart, nor could a symbolic habit manifest itself without the appropriate neuronal engravement. The one guarantees the other. Also, symbolical habit is altered when biological habit is altered, for example by an iron rod, passing through and destroying the brain, and vice versa; biological habit is altered when symbolical habit is altered, for example, by the consistent performance of a certain act and neuroplasticity.

It should be noted that the current essay is merely an initial reflection and not (yet) a well-developed theory in the least. Some critical reflections should also be uttered. Firstly, one's identity should probably also contain some physical aspects. Based on Locke's (1689/1849) analysis, even if two 'persons' are the same, they can never be the same 'man'. For example, consider a person and its twin-duplicate. They are exactly alike, except for the fact that the twin is twenty centimetres taller. In Locke's terms, they would be the same person, i.e. share the same rational being, but not the same man, i.e. they would not share the same material configuration. So, although in the slightest, their identities would differ. Habits, as used in the current essay, could never explain these concrete physical differences and could therefore, arguably, only explain mental identity (or 'person-ness'). So, at most, the current conception of identity as habit accounts for mental (i.e., conative, cognitive and affective) aspects of identity and not the contrasting physical aspects.

Secondly, identity can also refer to temporal or historical aspects of one's being. The former was seen in the notion of 'recovering Gage'. Lesion patients might be described as recovering, integrating that aspect of their temporal being in their identities. The difficulty, here, is that there is no consciousness that traces back to the past, which, according to Locke, is required to be a part of the identity. In the case of recovery, there is a constant inconsistency or disequilibrium. However, it could be proposed that this inconsistency is precisely the consistency (i.e., consistent inconsistency) and that, therefore, there still is a traceable consistency. This consistency, then, is part of one's identity. A recovering patient is a recovering patient, because his or her brain is engaged in an ongoing (materialistic and plastic) recovery process. Shortly put: not only active habits are relevant for identity, but also consistent neuroplastic processes. Either way, neuronal make-up (over time) still informs identity, even if this is perhaps more difficult to accept. Another difficulty arises when a full recovery (insofar that is possible) is considered. Once recovered, the patient becomes an ex-patient and might define him-/herself as a recovered brain trauma patient. This could be problematic because, while there is a consistency, it is not currently present. However, the latter is refutable and, therefore, less of a problem for the current proposal. Namely, as James

notes, the nervous system is plastic, but just like a crumbled plastic cup can never identically return to its initial configuration, so it is with the nervous system; once lesioned, a full recovery is impossible. Concretely, a partly healed brain injury, but a brain injury nonetheless, defines the agent as a ‘recovered trauma-patient’. So, here as well, neuronal make-up informs identity.

References

Bell, J., Crossley, N., Stephens, W. O., Sullivan, S., Leary, D., Watkins, M., ... & Des Chene, D. (2013). *A history of habit: from Aristotle to Bourdieu*. Lexington Books.

Carlezon Jr, W. A., & Thomas, M. J. (2009). Biological substrates of reward and aversion: a nucleus accumbens activity hypothesis. *Neuropharmacology*, *56*, 122-132. https://doi.org/10.1016/j.neuropharm.2008.06.075.

Carlisle, C. (2014). *On Habit*. Routledge.

Damasio, H., Grabowski, T., Frank, R., Galaburda, A., & Damasio, A. (1994). The Return of Phineas Gage: Clues About the Brain from The Skull of a Famous Patient. *Science*, *264*(5162), 1102-05. DOI: 10.1126/science.8178168.

Davis, M., & Whalen, P. J. (2001). The amygdala: vigilance and emotion. *Molecular psychiatry*, *6*(1), 13-34. https://doi.org/10.1038/sj.mp.4000812.

Dumont, L. (1876). De l'Habitude. *Revue Philosophique De La France Et De L'Étranger*, *1*, 321-66. Retrieved February 25, 2020, from www.jstor.org/stable/41071233.

Freud, S. (1917). *Mourning and Melancholia.* Colombia University Press. Retrieved June 23, 2020 from http://www.columbia.edu/itc/hs/medical/clerkships/psych/misc/articles/freud.pdf.

Girard-Tremblay, L., Auclair, V., Daigle K., Léonard, G., Whittingstall, K. & Goffaux, P. (2014). Sex Differences in the Neural Representation of Pain Unpleasantness. *The Journal of Pain*, *15*(8), 167-77. https://doi.org/10.1016/j.jpain.2014.05.004.

Goldberg, J. S., Bell Jr., C. E. & Pollard, D. A. (2014). Revisiting the Monoamine Hypothesis of Depression: A New Perspective. *Perspectives in Medicinal Chemistry*, *6*, 1–8. https://doi.org/10.4137/PMC.S11375.

Green, M. B., & Wikler, D. (1980). Brain death and personal identity. *Philosophy & Public Affairs*, *9*(2), 105-33. Retrieved March 3, 2020, from www.jstor.org/stable/2265108.

Harlow, J. M. (1993). Recovery from the passage of an iron bar through the head. *History of Psychiatry*, *4*(14), 274–281. https://doi.org/10.1177/0957154X9300401407. (Original work published in 1868.)

James, W. (1890). *The Principles Of Psychology Volume I*. Manipal University Dubai. Retrieved June 15, 2020, from http://library.manipaldubai.com/DL/the_principles_of_psychology_vol_I.pdf.

Johnston, A., & Malabou, C. (2013). *Self and emotional life: Philosophy, psychoanalysis, and neuroscience*. Columbia University Press.

Karl, J. R. (May, 2013). The maximum height of the maize subspecies: data. *Maize Genetics Cooperation Newsletter*, *86*, 2-3. Retrieved March 18, 2020, from https://www.maizegdb.org/mnl.

Locke, J. (1847). *An Essay Concerning Human Understanding*. Kay, C. H. (ed.). Kay & Troutman. https://books.google.com/books?hl=nl&lr=&id=2aw8AAAAYAAJ&oi=fnd&pg=PA1&dq=an+essay+concerning+human+understanding&ots=Z9d4k269RK&sig=0gH2zaaODXXI7_ghZH06Wo4fpkc. (Original work published in 1689.)

Macmillan, M., & Lena, M. L. (2010). Rehabilitating Phineas Gage. *Neuropsychological rehabilitation*, *20*(5), 641-58. https://doi.org/10.1080/09602011003760527.

Malabou, C. (2008). *What should we do with our brain?* Fordham University Press.

Malabou, C. (2019). *Morphing intelligence: from IQ measurement to artificial brains*. Columbia University Press.

Mancini, F., Sereno, M. I., Lee, M. H., Iannetti, G. D., & Tracey, I. (2019). Within-finger maps of tactile and nociceptive input in the human parietal cortex. *bioRxiv*, 599167. https://doi.org/10.1101/599167.

Merriam-Webster. (n.d.). Habit. In *Merriam-Webster.com dictionary*. Retrieved March 16, 2020, from https://www.merriam-webster.com/dictionary/habit.

Ogino, Y, Nemoto, H., Inui, K., Saito, S., Kakigi, R. & Goto, F. (2007). Inner Experience of Pain: Imagination of Pain While Viewing Images Showing Painful Events Forms Subjective Pain Representation in Human Brain. *Cerebral Cortex*, *17*(5), 1139–46. https://doi.org/10.1093/cercor/bhl023.

Ploner, M., Schmitz, F., Freund, H. J., & Schnitzler, A. (1999). Parallel activation of primary and secondary somatosensory cortices in human pain processing. *Journal of Neurophysiology*, *81*(6), 3100-4. https://doi.org/10.1152/jn.1999.81.6.3100.

Prather, S. C., Votaw, J. R., & Sathian, K. (2004). Task-specific recruitment of dorsal and ventral visual areas during tactile perception. *Neuropsychologia*, *42*(8), 1079-87. https://doi.org/10.1016/j.neuropsychologia.2003.12.013.

Rainville, P., Duncan, G. H., Price, D. D., Carrier, B., & Bushnell, M. C. (1997). Pain affect encoded in human anterior cingulate but not somatosensory cortex. *Science*, *277*(5328), 968-71. DOI: 10.1126/science.277.5328.968.

Rakic, P. (2002). Neurogenesis in adult primate neocortex: an evaluation of the evidence. *Nature Reviews Neuroscience*, *3*(1), 65-71. https://doi.org/10.1038/nrn700.

Ratiu, P., Talos, I. F., Haker, S., Lieberman, D., & Everett, P. (2004). The tale of Phineas Gage, digitally remastered. *Journal of neurotrauma*, *21*(5), 637-43. https://doi.org/10.1089/089771504774129964.

Ravaisson, F. (2008). *Of Habit*. Translated by Carlisle, C. & Sinclair, M. London: Continuum International Publishing Group. https://books.google.com/books?hl=nl&lr=&id=GzcdCgAAQBAJ&oi=fnd&pg=PR5&dq=ravaisson+habit&ots=cN9QLKHgE0&sig=ffKEGAETOhp9P51Zh6hVSmL5OUw. (Original work published in 1838.)

Rescorla, M. (2020). The Computational Theory of Mind, *The Stanford Encyclopedia of Philosophy*, Zalta, E. N. (ed.). https://plato.stanford.edu/archives/spr2020/entries/computational-mind/.

Santos E., Noggle C.A. (2011). *Synaptic Pruning*. In: Goldstein S., Naglieri J.A. (eds) Encyclopedia of Child Behavior and Development. Springer, Boston, MA. https://doi.org/10.1007/978-0-387-79061-9.

Sathian, K. (2005). Visual cortical activity during tactile perception in the sighted and the visually deprived. *Developmental Psychobiology: The Journal of the International Society for Developmental Psychobiology*, *46*(3), 279-86. https://doi.org/10.1002/dev.20056.

Sathian, K., & Stilla, R. (2010). Cross-modal plasticity of tactile perception in blindness. *Restorative neurology and neuroscience*, *28*(2), 271–81. https://doi.org/10.3233/RNN-2010-0534.

Sloterdijk, P. (2014). *You must change your life*. John Wiley & Sons.

Solms, M. (2000). Preliminaries for an integration of psychoanalysis and neuroscience. *Annual of Psychoanalysis*, *28*, 179-202.

Solms, M. & Turnbull, O. (2002). *The Brain and The Inner World: An Introduction to the Neuroscience of Subjective Experience*. New York: Other Press.

Spear, L. P. (2013). Adolescent neurodevelopment. *Journal of adolescent health*, *52*(2), S7-S13. https://doi.org/10.1016/j.jadohealth.2012.05.006.

Todd, A., & Wang, F. (2018). *Central Nervous System Pain Pathways*. In The Oxford Handbook of the Neurobiology of Pain. Wood, J (ed.). Oxford University Press. Retrieved 23 Jun. 2020, from https://www.oxfordhandbooks.com/view/10.1093/oxfordhb/9780190860509.001.0001/oxfordhb-9780190860509-e-5.

Tottenham, N., & Sheridan, M. A. (2010). A review of adversity, the amygdala and the hippocampus: a consideration of developmental timing. *Frontiers in human neuroscience*, *3*, 68. https://doi.org/10.3389/neuro.09.068.2009.

Wellhausen, E. J., Roberts, L. M., Hernandez X., E. (in collaboration with Mangelsdorf, P. C.). (1952). *Races of Maize in Mexico: Their Origin, Characteristics and Distribution*. The Bussey Institution of Harvard University. Retrieved March 18, 2020, from https://www.semanticscolar.org.

Yu, L. Q., Kan, I. P., & Kable, J. W. (2020). Beyond a rod through the skull: A systematic review of lesion studies of the human ventromedial frontal lobe. *Cognitive Neuropsychology*, *37*(1-2), 97-141. https://doi.org/10.1080/02643294.2019.1690981.

Zhao, C., Deng, W., & Gage, F. H. (2008). Mechanisms and functional implications of adult neurogenesis. *Cell*, *132*(4), 645-60. https://doi.org/10.1016/j.cell.2008.01.033.