Hacking our Brains for Learning

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ABSTRACT

Observational learning is ubiquitous. We very often observe and pick up information about how others behave and subsequently replicate similar behaviours in one way or another. Focusing on observational learning, I investigate human imitation, the mechanisms that underpin it as well as the processes that complement it, in order to assess its contribution to learning and education. Furthermore, I construe emotion as a scaffold for observational learning and bring together evidence about its influence on selective attention. Finally, I flesh out possible ways in which the insights about the role of imitation in learning could help design a more effective and equally rewarding learning environment. Specifically, I suggest that perhaps the simplest and most effective way to foster learning via promoting imitation is through letting learners of various ages co-exist. The benefits of learning in a mixed-age group are assessed.

[I]f you give a man a fish he is hungry again in an hour.
If you teach him to catch a fish, you do him a good turn.
Anne Isabella Thackeray Ritchie, 1885

1. Introduction

Observational learning is ubiquitous. We observe and pick up information about how others behave, how third parties react to a given behaviour, whether a given behaviour is location- or time-specific and subsequently replicate similar behaviours in one way or another. Observational learning is often considered an indirect way of learning, at least when compared to classical conditioning (e.g. Pavlov's famous dog experiment) and is not limited to any specific age-group, even though its role is more heavily pronounced during early developmental stages.

Observational learning is underpinned by our ability and tendency to imitate others. According to Bandura's (1977) Social Learning theory, we are naturally

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predisposed to imitate and thus engage in observational learning. Already from the first days of their lives young children exhibit the propensity to imitate facial expressions as well as mouth movements and later on start imitating much more complex behaviours. In their famous Bobo doll experiment (1961), Bandura and colleagues show that children who watch an adult model being violent to an inflatable balloon doll, are more likely to replicate this behaviour later on when they are allowed to play in a room with a real Bobo doll. This mimic behaviour is more evident when the model in the watched clip is rewarded for the exhibited violent behaviour, while it diminishes if the model is 'punished' for it. This shows that children are more likely to imitate socially acceptable behaviour, regardless of the actual 'content' of the behaviour. Hanna and Meltzoff (1993) show that infants are very effective social learners, as well as capable of imitating from memory, e.g. observe an action and execute it later on, which is the sine qua non for learning.

In this paper, I investigate human imitation, the mechanisms that underpin it as well as the processes that complement it, in order to assess its contribution to education.[1] Furthermore, I examine how central imitation is to current learning environments and how the latter could adjust in order to benefit from it. Differently put, given that our brains have evolved for perception and action and have developed dedicated neural circuits, mechanisms and processes for learning, like imitation, it seems only intuitive to invest in learning environments (especially for young learners) that precisely build upon these powerful learning tools of ours.

A number of preliminary points are worth clarifying at this stage. First, I do not suggest that imitation could or should substitute theoretical teaching altogether. Rather I suggest that putting more emphasis on imitation can enhance learning and make the learning experience much more rewarding for learners, especially for those of young age.

Second, the role of imitation in learning varies across different subject matters as well as across different developmental stages. Usually, younger children learning how to deal with concrete tasks, e.g. tying a knot, rely more on imitation in comparison to adults learning physics. Nevertheless, imitation

[1] There are varying views about the nature of imitation. For instance, Meltzoff and Moore (1997) construe imitation as a matching-to-target process; Tomasello, Kruger and Rantner (1993) offer a social enculturated theory of imitation; Byrne and Russon (1998) argue that imitation can occur at various levels and that an action can be learned without imitation. I do not further elaborate of these views in this paper and simply adopt a regular view of imitation as copying an observed behaviour.

can still be of great help for all learners that learn how to deal with demanding cognitive tasks such as algorithmic reasoning for instance. Seeing a favourable model approaching mathematical equations in a specific way – rather than listening to someone merely explaining the relevant principles – can allow subjects to learn how to cognitively deal with demanding cognitive tasks more effectively. This claim resonates Goldstone et al.'s (2017) 'Rigged Up Perception-Action Systems' (RUPAS), and Ottmar et al.'s (2015) 'Graspable Mathematics', two tools that precisely integrate theory and perceptual learning in order to teach learners how to construe algebraic notation. Specifically, according to RUPAS converting highly sophisticated, cognitively demanding and strategically-controlled operations, like algebraic reasoning, into learned and automatically deployed perception-action routines significantly enhances learners' performance.

Third, imitation should be construed broadly in the sense that learners do not simply copy a model's actions but rather pick up information about *why* this action should be copied, most often based upon peer reactions, environmental settings and so forth. For instance, seeing a model being satisfied after completion of a hard task, like learning to solve a specific type of mathematical problems, can motivate the learner and trigger a similar behaviour (of studying hard, in addition to the way the model approached the actual mathematical problem in question). Acquiring such general attitudes towards studying and learning is key for a learner's development.

I start by investigating the mechanisms that underpin imitation and explore empathy and gaze-following, which I argue complement imitation and ultimately enhance learning. Furthermore, I look into emotion and its influence on selective attention which heavily influences observational learning. Finally, I flesh out possible ways in which the suggestions put forth here could be implemented in designing a more effective and equally rewarding learning environment.

It is worth clarifying at this point that the claims made here about the contribution of emotion to learning are not necessarily novel in their entirety. What is novel are the ways in which the insights about the contribution of emotion to manipulation of selective attention or memory formation, for instance, are used in suggesting how formal educational settings can provide a more stimulating and ultimately successful learning environment.

2. We are hardwired to imitate

Imitation is key for our cognitive and social lives. We look and learn how to cope within social groups, what to avoid and how to succeed when dealing with novel situations. Interestingly, we humans imitate in ways that no other animal does. In comparing human subjects to primates (bonobos) Zanna Clay and Claudio Tennie (2017) argue that unlike other animals, humans exhibit extraordinary readiness to imitate not only novel actions but also actions that are visibly casually irrelevant. Furthermore, Meltzoff (2005) argues that even though many animals watch their conspecifics and get involved in similar activities (to the ones their conspecifics execute), this is frequently mediated by processes that are much simpler than imitation.

Susan Blackmore (2007) argues that imitation defines us and it is what makes us human. For Blackmore, all evolutionary processes depend on information being copied with variation and selection, but it is only humans that are also meme machines, i.e. machines that produce something that is imitated (cf. Dawkins, 1976). Adopting a gene's perspective, Blackmore argues that genes try to survive and get copied. The gene tries to get humans to pay attention to it and pass it on.

Regarding the neuronal underpinnings of imitation, Iacoboni et al. (1999) argues that imitation may be based on a mechanism that directly matches observed actions onto internal motor representations of that action. Famously, they tested this hypothesis by asking normal human subjects to observe and imitate a finger movement as well as to perform the same movement on perception of spatial or symbolic cues. The participants' brain activity was measured using functional magnetic resonance imaging (fMRI) and two areas (in the left inferior frontal cortex (opercular region) and the rostral-most region of the right superior parietal lobule) were found to be active during finger movement, regardless of the condition under which it was evoked. The observed results show that activity in these two areas (specifically, in the pars opercularis of the left inferior frontal gyrus (IFG), the right anterior parietal region, the right parietal operculum, and the right STS region) was increased when the movement was activated by observing another individual executing the same movement (mirror effect).

Ferrari et al. (2003) who studied area F5 of the monkey premotor cortex report that approximately 25% of studied "mouth" neurons exhibit mirror properties. Based on the visual stimuli that were effective in triggering the neurons in question, two kinds of neurons are distinguished. First, neurons that were activated during perception of actions related to ingestive functions, e.g. grasping food with mouth, sucking, and so forth. Second, certain neurons that were activated by communicative gestures such as lip smacking. Importantly, both of these kinds of neurons motorically behave like ingestive mirror neurons, strongly discharging when the monkey executes an ingestive action.

Nishitani & Hari (2002) used magneto-encephalography (MEG) and show that observing still pictures (which only imply action) of verbal and non-verbal (grimaces) lip forms, and imitating them activates the same brain regions. Furthermore, the progression of cortical activation was the same both during observation and execution (activation started from the occipital cortex to the superior temporal region, the inferior parietal lobule, IFG (Broca's area), and ended to the primary motor cortex).

The above is only a small sample of the large pool of evidence for mirror neurons and show that even though these neurons reside in motor areas they are bestowed with visual properties that match the execution of an action with its perception (cf. Gallese 2001; Gallese & Keysers, 2001; Gallese et al. 1996; Rizzolatti et al. 1996; Umiltà et al. 2001; Rizzolatti & Luppino, 2001).[2] In light of this evidence, it is safe to argue that we are hardwired to imitate.

3. Learning to learn

One of the most interesting characteristics of the mirror neuron system, especially with regards to learning, is that its mirror properties are neither wholly fixed nor genetically predetermined. Rather the mirror system is flexible and susceptible to training.

In investigating how mirror neurons acquire their mirror properties and thus how they derive the information necessary to match the observed actions with executed ones, Catmur and colleagues (2007) show that it is possible to manipulate the selectivity of the human mirror system and to make it operate as a countermirror system. In particular, they trained participants to perform index-finger movements while observing little-finger movements and vice versa (incompatible training). Before this training, subjects exhibited event-related muscle-specific responses to

[2] See Zipoli Caiani (2014) for a detailed discussion.

transcranial magnetic stimulation (TMS) over motor cortex while observing little- and index-finger movements. Interestingly, after a relatively short training this normal mirror effect was reversed. This suggests that the mirror properties of the mirror system are neither wholly innate, nor are they fixed once acquired. Rather the mirror system is a product and a process of social interaction (Heyes, 2001 in Catmur et al. 2007) and contributes greatly to our ability to interact in a complex social environment. In turn, this shows that imitation is not only key for learning but also that learning is in a sense key for imitation, if only to the extent that experience can reconfigure the mirror system. In turn, this evidence puts the emphasis on learning and stresses the results that it has especially for the developing brain.

The above evidence suggests that the mirror system also depends on the availability of correlated sensorimotor experience in our immediate sociocultural environment (Catmur et al., 2007). This stresses the importance for designing learning environments that nourish our imitating and memetic abilities. Learning environments should first and foremost teach learners how to learn and how to produce memes or behaviours that will be imitated. As it happens, systems or early education focus on providing learners with "ready-to-use knowledge".

3.1 Imitation, emotion, empathy & attention

The contribution of imitation to learning can be further illustrated by appealing to the role of emotion, empathy and attention both in imitation and learning. In order to fully appreciate the relations in question, the present view builds upon the following associationist hypothesis.

Stored information is structured in the human mind in the form of representational networks, which are ultimately grounded in ensembles of associated neurons. The connections between these representational networks are heavily influenced by frequencies of co-occurrences. That is, the more frequently two pieces of information become co-activated, the stronger the connection between them will grow. Stronger connection weightings between emotional states and things in the world is couched here in terms of formation of direct connections to selective attention and working memory (cf. Derakshan & Eysenck, 2014).[3]

[3] Working memory capacity is associated with a number of emotional aspects, including states of depression and stress, as well as reactions to emotional stimuli, and regulatory behaviours (Takeuchi, et al., 2014).

The stronger the connection between two neurons (or neuronal ensembles), the greater the probability that activation of one will trigger activation of the other. This resonates Hebb's (1949) famous rule of learning according to which 'neurons that fire together, wire together'.

In addition to frequencies of occurrences, connection weightings are also influenced by selective attention. In turn, selective attention is influenced both by factors internal-to-the-mind (top-down attention) as well as external (bottom-up attention).[4] Importantly, emotion drives selective attention as they allow us to single-out things or aspects of things in the world that are trivial and focus on what is important. For instance, when threatened by the presence of a predator, the emotional state of fear drives selective attention to the predator and a potential escape route rather than to the colour of the sky (cf. Thagard and Nussbaum, 2014).

Furthermore, emotion allows for associations to be formed fast – after a single or in any case very few repetitions. In this sense, a subject does not have to go through the same painful or fearful experience more than once (single trial memory) in order to form the association between a knife, for instance, and the feeling of pain or the emotional state of fear and so forth (cf. Tillas, 2016). An evolutionary explanation of why emotional states form stronger associations faster in comparison to associations between representations of 'regular' features in the world is precisely because they play a crucial role in learning (cf. Thagard and Nussbaum, 2014), and drive attention to things in the world that are important to us.

The role of emotion in learning is not limited to formation of associations between features in the world. Praise can motivate people, feeling bad (negative affect) for not scoring high at a test can either motivate learners to bounce back or to give up altogether.[5] Peer pressure can put a young learner under stress, even though some children can use that to become motivated. Haun et al. (2014) show that young children experience peer pressure and imitate other kids simply to fit in. The role of empathy, which I examine below, is important in this process. Seeing others being praised or rejected urges us to do something or avoid doing it respectively.

[4] Bottom-up attention refers to attention captured by salient features, while top-down allocation of attention refers to attention driven by one's intentions, e.g. Looking for a set of keys in a drawer.
[5] Motivation is important for learning since motivated learners can focus more fully on the task or activity they perform, work for longer periods and deploy more thoughtful strategies (cf. Hidi & Renninger, 2006).

3.2. Attention & learning

As explained, emotion contributes to learning by facilitating formation of associations between representations stored in memory. Specifically, selective attention is inherently linked to working memory (WM), a relation that has traditionally been construed as unidirectional. That is, selective attention is often seen as filtering out non-attended information (Cowan, 1995; Duncan, 1996; Rensink, 2002, reported in Downing, 2000). This intuitive claim enjoys support from evidence showing that our perceptual system cannot possibly process all information present at any given scene, (cf. Barsalou, 1999; Findlay and Gilchrist, 2003), while attended information is allowed into short-term processes. Recent updates to these views suggest that the *contents* of visual working memory guide selective attention. Downing (2000) reports a study, which suggests that maintaining items in WM is attentionally demanding. In this study, subjects were asked to hold a sample object in working memory, while being shown two objects, one matching the sample and a novel one. The results show that attention shifts to the object matching the sample. Thus, it is argued, the content of working memory drives attention in a top-down manner. Top-down attention has stronger positive memory effects in cognitive tasks, in comparison to bottom-up attention, since top-down attention enhances formation of representations of attended features, (cf. Corbetta et. al., 1990; Noudoost et. al., 2010). Moreover, information attended through top-down attention is more relevant for memory formation (Uncapher et. al., 2011) or later remembering (Craik et. al., 1996).

Despite the important contribution of attention to encoding, manipulation of information and ultimately learning, attention is only minimally involved in maintenance of information in working memory (Downing, 2000). Assuming that retaining a given piece of information in working memory for longer allows for extensive processing along with a larger window of opportunity to transfer this information to long-term memory, emotion seems to compensate for the aforementioned minimal role of attention in maintaining information in WM. Thus, combining attention and emotion enhances memory formation and learning. Furthermore, emotion drives attention in a more 'decisively' manner than other stored representations, as they force the subject to selectively attend to specific aspects of the perceived stimuli regardless of influences be they external or endogenous to the subject. For instance, the emotional state of fear in the presence of a predator monopolises attention to the expense of any other top-down influences from other stored representations. Similarly, emotion drives selective attention to features in the world for much longer.

Once again, even though attention does not in principle contribute to maintaining WM information, once driven by emotion, the process of forming and manipulating information is prolonged, and thus enhances long-term memory formation and learning.

Osaka et al. (2013) investigated whether and when emotion modulates WM from a neuronal activation perspective. In particular, they measured brain activity during encoding and retrieving information of a reading span test (RST), which used emotional contexts.[6] Subjects were asked to read sentences that elicited negative, neutral or positive emotional states and to memorise target words from the sentences. The negative emotion RST activated the right amygdala during the reading phase, while the positive RST activated the substantia nigra during the reading phase (when compared to the neutral RST). On these grounds, Osaka et al. argue that negative and positive emotion modulates WM through distinctive neural circuits. This shows that participants struggled to inhibit the negative emotion elicited by the negative sentences. The elicited emotion affected RST performance by consuming attentional resources. Activation of amygdala suggests that negative emotional sentences accelerate the encoding of stimulus sentences into episodic memory. This in turn suggests that emotion enhance memory formation and ultimately learning.

3.3. Imitation & Empathy

Empathy is the ability we have to understand and share the feelings of others and is naturally very important to learning especially when seen alongside imitation. Adolphs et al. (2000) highlight the relationship between somatosensation and emotional recognition and argue that on perception of a facial expression of a given emotion, the observer unconsciously empathises and goes through the same emotional states, if only phenomenologically less intensely. Through this process, the subject associates the distal cause of the perceived emotion and learns that a specific stimulus can trigger emotion *x* or *y* (at least to agents in some respect similar to her).

When observing a model, a learner picks up abundant information about execution of a given behaviour and so forth. Furthermore, the reaction of her

[6] Typically, in an RS Test participants are required to read series of unconnected sentences aloud and to remember the final word of each sentence.

peers during the model's performance (assuming that the model executes the behaviour in question in front of an audience) influence the learner's attention allowing her to single out what is important or trivial, accepted or not, and so forth. Also, by recognising her peers' emotional reactions and emphatising with them, in the way explained above, the learner forms new associations faster than simple theoretical instruction would ever allow her to. In this sense, imitation provides the grounds for more effective learning, if only by providing the grounds to exploit recognition of emotional reactions through empathy.

Our ability to associate emotional states to appropriate information is facilitated further by our capacity to follow gazes. Brooks and Meltzoff (2005) show that 10 months and 11 months old infants begin to understand that their conspecifics are 'visually connected' to the world and thus understand adult looking differently. Gopnik, Meltzoff and Kuhl (1999) argue that gaze following also helps children understand emotion and their relation to the world. For instance, following an adult's gaze who is frowning (proximal cue) allows the child to understand the (distal) cause of the drawn facial expression. In this way, they associate the empathised emotional state with the thing in the world to which the observed actor (usually parent) attended. To make this more concrete, "a mother looking scared" is key for learning what danger is. And this is equally the case for human and non-human subjects (Sterelny, 2003). Bolten and Schneider (2010) also argue that observational learning contributes greatly to the development of anxiety, and they show that looking at a mother's scared facial expressions is responsible (alongside genetic factors) for the development of anxiety disorders and naturally affects infants' behaviour in novel and ambivalent situations (e.g. visual cliff setting).

Thus, empathy and gaze-following allow us to effectively learn what is important in our immediate environment, how certain seemingly unrelated features in the world are connected and how to deal with novel situations.

4. Imitation and confabulation

In order to highlight the role of imitation in learning further, I compare teaching through imitation and preaching. Famously, Bryan (1971) measured the effects of imitation on generosity and reports that if children see a generous model (a model donating to a charity jar for instance), they exhibit a more generous behaviour than without seeing one. In contrast, when exposed to a non-generous model, children donate less than they would have without exposure to a model. The effects of exposure to a model endure over months in retests (in the absence of the model) and also extend to somewhat similar contexts.

In a series of similar experiments Bryan and Walbek (1970) compared the behavioural effects of preaching and imitation and report that a model's acts affected the child's donation behaviour to a much greater degree than the model's exhortations (for the benefits of generosity). In a different experiment, Bryan and Walbek report that both preachings and practices were found to be important determinants of the judged attractiveness of the model, even though preaching, once again, failed to have a significant impact on donation behaviour. In this sense, words and deeds seems to have different effects on behaviour, and the two do not appear to be intersubstitutable, even though children are usually overexposed to the value of generosity. Grusec (1971) and Presbie and Coiteux (1971) report compatible results.

Hartup and Coates (1967) also report that subjects exposed to an altruistic peer model exhibited significantly more altruism than subjects that were not. Furthermore, they found that when peer reinforcement is frequent, subjects have a greater incentive to match a rewarding behaviour than a non-rewarding one. In contrast, when peer reinforcement is infrequent, subjects tend to imitate nonrewarding peers significantly more than rewarding ones.[7]

Finally, Rushton (1975) reports that the effects of preaching about the benefits of generosity were evident in the long run but not in the short run. Interestingly, observing a model was highly effective both in the short- and long-term, which suggests that subjects have internalised the observed behaviour. It seems intuitive to assume that based on observation of the model as well as her peers, the learner also internalises a set of principles, if only tacitly and perhaps non-propositionally. This tacit knowledge can become explicit once the subject is asked or wonders about the underlying principles of her behaviour. To illustrate this point further, I appeal to the seminal work of Nisbett and Wilson (1976) on confabulation.

Famously, Nisbett and Wilson (1976), asked subjects in a bargain store to judge which one of four nylon-stocking pantyhose was the best quality. The stockings, which were in fact identical, were presented on racks spaced equal distances apart. As situation would have it, the position of the stockings had a significant effect on the subjects' choice. In fact, 40% of the subjects chose the far right –and most recently viewed-pair. When asked to explain their

[7] See also Heinrich and Heinrich (2007) for a detailed discussion of related issues.

judgements, most of the subjects attributed their decision to different characteristics such as the knit, weave, elasticity, etc. of the stockings that they chose to be of the best quality. Following Hirtsein's (2005) perspective on confabulation, the subjects do not lie but do try to rationalise their judgements and choices. Analogously, learners in the above charity-box case can confabulate about the theoretical underpinnings of their behaviour and in this way rationalise and form a set of principles about the benefits of generosity.

Thus, allowing the learner to imitate a generous action and confabulate later on a set of principles that she whole-heartedly believes and practices can be more effective than preaching. Furthermore, this highlights the broad scope of information that a learner picks up when observing others.

5. Putting it all together

In the previous pages, I stressed the importance of imitation in learning and highlighted the processes that underpin and complement it. The above analysis suggests that the single most important aspect of learning is manipulation of attention, while imitation precisely provides the grounds for attracting and maintaining an observer's attention, when compared to preaching. Designing a learning environment that builds upon imitation seems like the most effective way to fully exploit our natural propensities to learn or, if you prefer, provides insights about how to hack our brains and tune them up for learning. In this final section, I bring this evidence together in order to make general suggestions about how to provide learners with a more effective and equally rewarding environment.

5.1. Learning the natural way: From Emotion to imitation via empathy

Under the right circumstances emotion can manipulate our attentional resources, in the broad sense of the term. This characteristic of emotion can be put to work with regards to learning when paired with empathy and imitation. Specifically, our natural drive to empathise with our peers allow us to experience similar emotional states to the ones the peer we observe experiences. Consider for instance the case of empathetic stress, where subjects experience stress simply by watching others under a stressful condition and despite being obvious and beholders being reassured that they themselves are not and will not be put under any similar condition. Interestingly, stress becomes contagious even when watching strangers being under stress (cf. Engert et al., 2014).

In this sense, the beholder empathises and thus shares the emotion of the observed subject. This sharing of the emotion is key for learning for a number of reasons. First, it allows the subject to experience and in turn associate a given emotional state to a novel and previously unconnected stimuli. Sharing a given emotion, like fear for instance, paves the way for flagging out the novel stimulus as important, dangerous, and crucially as avoidable.

To illustrate the importance of empathy in learning further, consider a beholder watching someone struggling to descent a terrifying cliff face. Assume that the beholder is ignorant about the potential danger of high drops, and assume further that the beholder cannot empathise with the descending climber. Under these conditions, it is hard to imagine how the beholder could learn that high drops are dangerous, at least on this particular occasion alone. In this sense, it seems intuitive that information about the danger lurking in high drops would have been more effectively conveyed if the observer could actually empathise with the observed subject in this particular experience. Luckily for us learners, we are neuroanatomically hardwired to become aware and understand other people's emotional states most probably through activation of the anterior insular cortex (cf. Gu et al, 2012). Interestingly, anterior insular cortex lesions have been associated with deficits in emotional awareness (termed as *alexithymia*), (*ibid.*).

Coupling empathy with gaze following, in the way explained above, allows us to mine information about novel stimuli and further allows us to pinpoint the exact object of the observed subject's attention. In this sense, empathy and gaze following underpin learning to the extent that they ultimately point our attention to the ways our peers successfully (or not) manage new stimuli.

A further utility of this learning toolkit, if you like, is that it is a remedy to the fact that our attention span plummets fairly fast. Emotion can secure that our attention is maxed out. For as explained emotion not only drives attention to what is important but also deploys all of our attentional resources for a specific purpose and importantly for as long as it is necessary – recall the aforementioned escaping-a-predator example. Furthermore, emotion allows for direct connections to selective attention and working memory, as shown above (§3.1), which suggests that in this way we can pick up and importantly retain information about the world effectively.

It is worth clarifying at this point that imitation, emotion, and empathy as 'learning aids' are not limited to a one-to-one level. That is, a learner learns through empathising not only with an acting model but also with other learners watching the same model. Specifically, when observing a model, a learner does not only pick up abundant information about execution of a given behaviour or task but also about the reaction of her peers during the model's performance (assuming that the model executes the behaviour in question in front of an audience). Peer reactions influence the learner's attention allowing her to single out what is accepted or not, important or trivial and so forth. Also, by recognising her peers' emotional reactions and emphathising with them, in the way explained above, the learner forms new associations faster than simple theoretical instruction would ever allow her to. In this sense, imitation provides the grounds for more effective learning, if only by providing the grounds to exploit recognition of emotional reactions through empathy.

5.2. Shortcomings of learning environments

The above analysis on imitation presents evidence that are fairly well known both to education policy makers and educators. Yet exploiting the aforementioned propensities of ours for teaching purposes is only limited, while preaching is still a teacher's bread and butter, as has always been. And even in cases where imitation is used fairly systematically for teaching purposes, a number of key characteristics of how humans imitate and learn are ignored. For instance, it is ignored that children are better at imitating peers than adults, and also that children will not imitate any behaviour but rather a behaviour that is socially (peer) accepted. In this sense, children would learn a new practice more effectively were they to imitate their 'expert' peers as their attention levels would not drop as easily and so forth.[8] It is worth clarifying at this point that 'peer' in this context is construed rather broadly, and not necessarily as meaning learners of the 'exact same age'. In addition, given that older children are more knowledgeable than younger ones and have more cognitive resources, suggests that having older peers in the group greatly facilitates imitation and ultimately learning.

One of the most easily recognisable problems of the learning environment that a traditional classroom can ever provide is that it cannot readily accommodate the unique ways and pace in which different learners learn. And if we ignore the unique characteristics of each learner, we simply force them to learn and let go of all of the aforementioned learning natural propensities. At the

[8] 'Expert' peers are peers that know how to deal with a given situation that is novel-to-the-naïve learner.

same time, forced education pays little attention to a learner's creativity, makes them bored easily and largely spoils learning for them.

Moreover, the way current educational systems measure learners' progress spoils learners' motivation to learn. Consider for instance having a marking system that unavoidably characterizes a learner as above or below par. In such cases, emotion and empathy are often used in the guise of guilt and shame on the one hand, and pride and brag on the other, rather than fuel to the learner's motivation.[9]

These mismatches between our learning propensities and established learning environments suggest that our naturally evolved abilities to imitate and empathise do not always blend well with social environments like the ones provided in traditional classrooms. That is, our instinct to imitate might have the opposite to the desired result when not treated in the right kind of way. For instance, it is quite common for learners in a standard learning environment to put more effort in trying to be liked, approved or accepted by their peers as well as teachers, than getting satisfied from the learning experience. Of course, trying to excel is by no means a bad thing. Quite the opposite. And remaining motivated to learn, and getting satisfying while doing so, is precisely what can make someone excel and keep exceling. It is just that having marking systems and examinations of probably any form that lead young students to 'succeed' or 'fail' seems to have the opposite result to fostering learning as it eradicates motivation or at least the right kind of motivation. Learning for others, in the sense explained above, is ineffective as it can be easily replaced by other ways to achieve peer acceptance, like being funny or good at other things. Most crucially though, it often leads learners to learn about things they do not like, care about, or intend to make use of. And knowledge acquired in this way or knowledge that is not (often) retrieved is grounded in associations whose connections weightings will inevitably become ever so weak.

5.3. Where do we go now?

Given the seriousness of the issue at stake, I do not imply that there is an easy answer for how to design the perfect learning environment, should a thing like that really exist. But given the insights gained by research in cognitive

[9] See Soroa et al. (2015) for a systematic analysis of the interrelations between emotion, cognition and motivation and their influence on creativity. See also De Dreu, Baas, and Nijstad (2008) for a detailed discussion about how mood activation and mood valence influence aspects of creativity.

neuroscience and psychology, it seems that we could be closer than ever to designing a learning environment that promotes our natural curiosity, fosters creativity or at the very least does not go against our own nature (as learners).

In light of the evidence presented here, I can at least sketch a framework that fosters learning through promoting deployment of these natural propensities and brain processes or a system that puts imitation, emotion, empathy and attention to work (for learning). A learner-friendly learning environment respects the learner's interests as well as the fact that every learner learns at her own pace and way. These are basic and intuitive claims but ones that are hard to implement in a conventional classroom environment. Perhaps, changing the conventional classroom is part of the solution to the aforementioned problems.

Admittedly, it is not always easy to have a model showing 'a target subject matter' to classes. And it is even harder for a model to show different concepts in ways that do not overlap with each other, as this would lead to loss of interest and even confusion. One way to foster learning via promoting imitation is through letting learners of various ages co-exist. One simple change in traditional schooling that can go a long way. Having a mixed-age group of learners provides a platform for fertile and essential exchange of ideas, views, gestures, attitudes, behaviours and so forth, (cf. Gray and Feldman, 1997; 2004). Young children in a mixed-aged group are exposed to an unparalleled wealth of novel modes of thinking, strategies, techniques, and information. At the same time, older peers, who are playing the role of experts are equally benefited. First, they exploit their natural inclination to produce memes. Second, they learn how to lead, nurture and be the mature person in a relationship (Gray, 2013: 101). In order for this learning environment to be functional and effective a number of further factors of course have to be in place.

Children have to be allowed space and time to interact with each other; they have to be granted the freedom to play, which is one of the most effective ways to learn (Grey, 2013). In this way their interest, curiosity and ultimately attention is maintained at high levels, which as explained grounds learning. Children can of course always ask expert peers about how something is done, or simply imitate them, especially at younger ages. This unconstrained exchange of ideas is of significant benefit for both 'naïve' and 'expert' learners, in the way explained above.

By stating that children pay closer attention to their peers does not means that they do not attend or imitate the actions of adults. After all humans learned how to fly by imitating the way birds fly. In this sense, both naïve and expert learners should have access to a knowledgeable adult that can guide them through a process that is novel to them and not always easy to follow, or simply support them or offer a lap to sit on or a shoulder to cry on. The presence of adult experts (teachers) in the classroom is key as children can imitate their practices as well, listen to their conversations and incorporate this new information in their activity. Importantly, choosing to listen to an adult's 'instructions' makes all the difference when compared to being forced to do so. Simply compare students calling out for an adult instructor to help them understand a novel concept to students being sat on a chair forced to listen to the very same piece of information while they are all but interested in this topic (at least on that given moment in time). To make things worse, these uninterested learners know that they will soon be tested on this piece of information before they can forget all about it. Attention in the former case will span for as long as it is necessary for the curious learner to learn about the topic of her interest on a given occasion. With regards to the latter, attention was never in the frame.

In this sense, perhaps designing a more effective learning environment simply means observing and imitating how children learned throughout history, and how they mingled with their peers long before modern schooling developed.

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