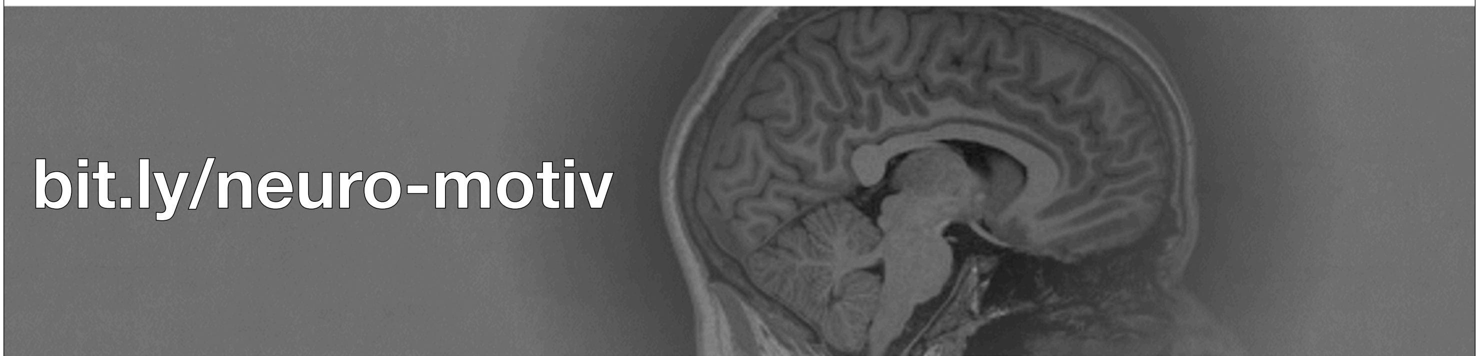
labneuroeducation.org youtube.com/stevemasson facebook.com/profstevemasson twitter.com/stevemasson

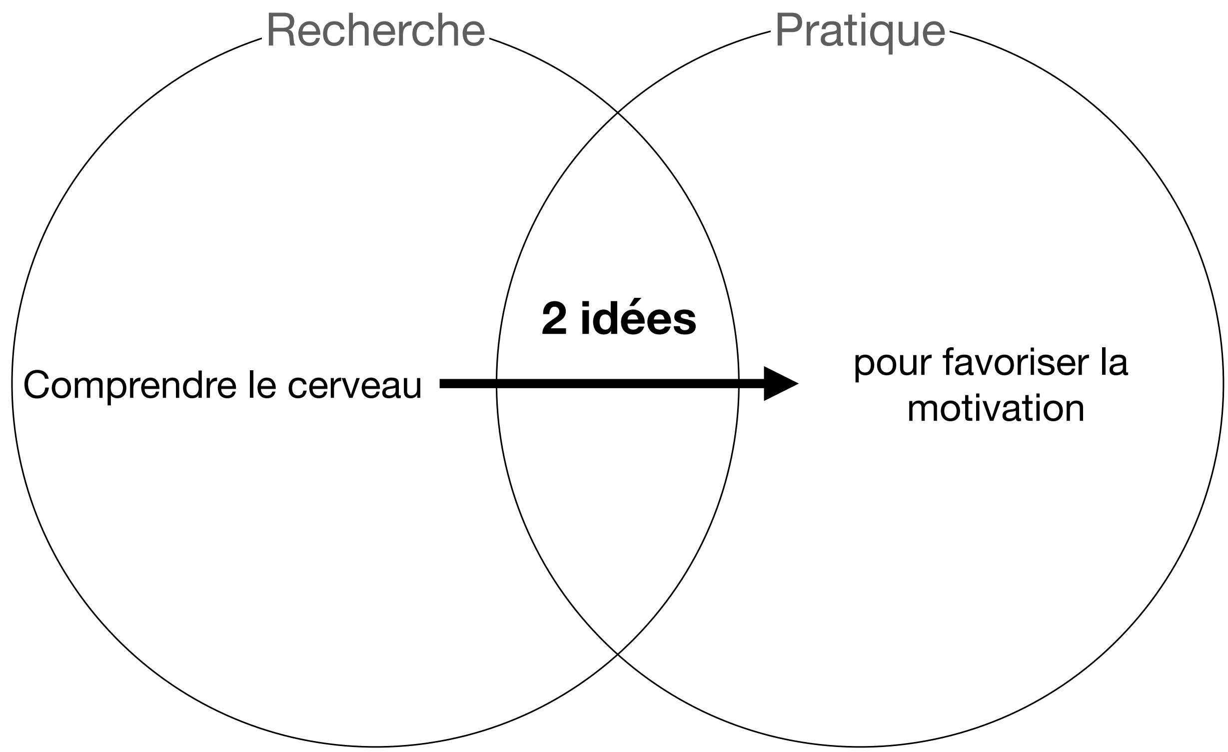


Comprendre le cerveau pour favoriser la motivation

Webinaire organisé par PRECA - 15 février 2021
Steve Masson, professeur à l’Université du Québec à Montréal

Motivation

volonté d’agir pour atteindre un **but**,
malgré les **efforts** qui sont requis



Analyse

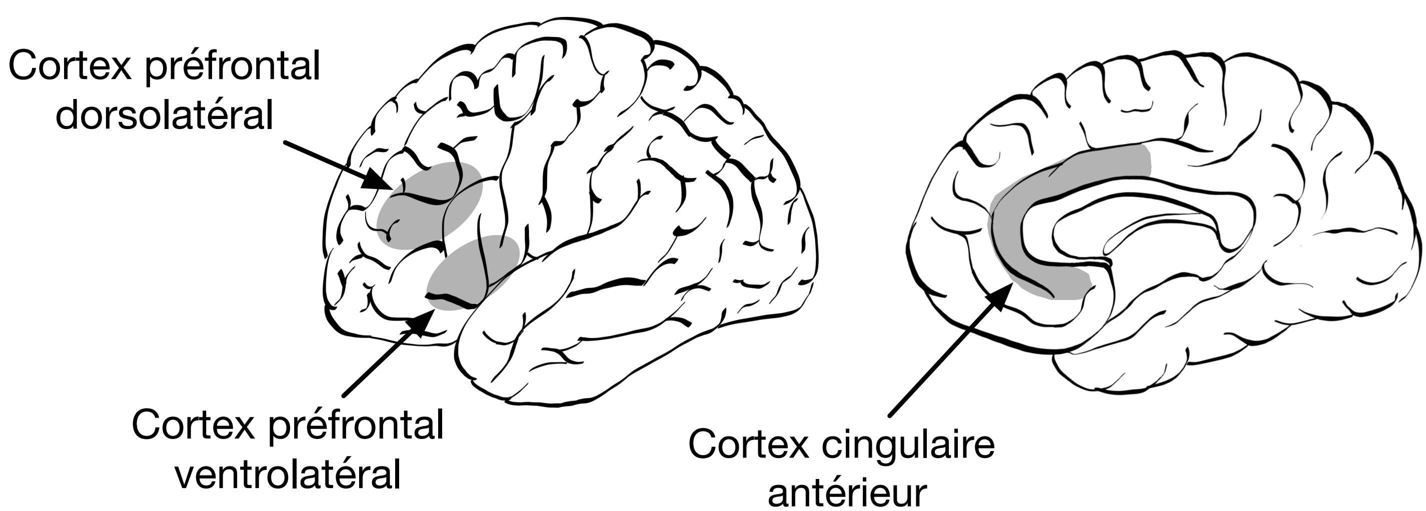
coût

vs

bénéfice

Idée 1

Coût (effort)



Déterminant dans l'analyse coût-bénéfice

Croire qu'on peut s'améliorer

État d'esprit

Dynamique

Croire qu'on peut s'améliorer

Fixe

Ne pas y croire

Étude de Moser et al.

Research Report

Psychological Science
22(12) 1484–1489
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DOI: 10.1177/0956797611419520
http://pss.sagepub.com
SAGE

Mind Your Errors: Evidence for a Neural Mechanism Linking Growth Mind-Set to Adaptive Posterror Adjustments

Jason S. Moser[1], Hans S. Schroder[1], Carrie Heeter[2], Tim P. Moran[1], and Yu-Hao Lee[2]
[1]Department of Psychology and [2]Department of Telecommunications, Information Studies, and Media, Michigan State University

Abstract

How well people bounce back from mistakes depends on their beliefs about learning and intelligence. For individuals with a growth mind-set, who believe intelligence develops through effort, mistakes are seen as opportunities to learn and improve. For individuals with a fixed mind-set, who believe intelligence is a stable characteristic, mistakes indicate lack of ability. We examined performance-monitoring event-related potentials (ERPs) to probe the neural mechanisms underlying these different reactions to mistakes. Findings revealed that a growth mind-set was associated with enhancement of the error positivity component (Pe), which reflects awareness of and allocation of attention to mistakes. More growth-minded individuals also showed superior accuracy after mistakes compared with individuals endorsing a more fixed mind-set. It is critical to note that Pe amplitude mediated the relationship between mind-set and posterror accuracy. These results suggest that neural mechanisms indexing on-line awareness of and attention to mistakes are intimately involved in growth-minded individuals' ability to rebound from mistakes.

Keywords

individual differences, electrophysiology, cognitive processes

Received 2/22/11; Revision accepted 7/11/11

> Whether you think you can or think you can't—you are right. (popularly attributed to Henry Ford)

Decades of research by Dweck and her colleagues indicate that academic and occupational success depend not only on cognitive ability, but also on beliefs about learning and intelligence (e.g., Dweck, 2006). Dweck's model of implicit theories of intelligence (TOIs) distinguishes people who believe intelligence is unchangeable (i.e., those who have a *fixed mind-set*) from people who believe intelligence is malleable and can be developed through learning (i.e., those who have a *growth mind-set*). It is critical to note that these mind-sets are associated with different reactions to failure. Fixed-minded individuals view failure as evidence of their own immutable lack of ability and disengage from tasks when they err; growth-minded individuals view failure as potentially instructive feedback and are more likely to learn from their mistakes (Dweck, 1999; Utman, 1997).

Despite years of work examining the self-report and behavioral correlates of these different mind-sets, little is known about the neural mechanisms that underlie them—only one study has examined the neural underpinnings of mind-set. In that study, Mangels, Butterfield, Lamb, Good, and Dweck (2006) measured event-related potentials (ERPs)—electrical brain signals elicited by external or internal events—in college students endorsing a fixed or growth mind-set while they performed a difficult general knowledge test. They found that compared with fixed-minded individuals, growth-minded individuals allocated more attentional resources to corrective information following error feedback and were more likely to correct their mistakes on a surprise retest.

Although Mangels et al. (2006) found differences between individuals with fixed versus growth mind-sets in neural and behavioral responses to corrective information, they demonstrated these effects on a task in which performance accuracy was ambiguous. Participants became aware of their mistakes only when they were signaled by external feedback. This task was also quite difficult (success rates were kept at ~40%), which may have exaggerated differences between the groups

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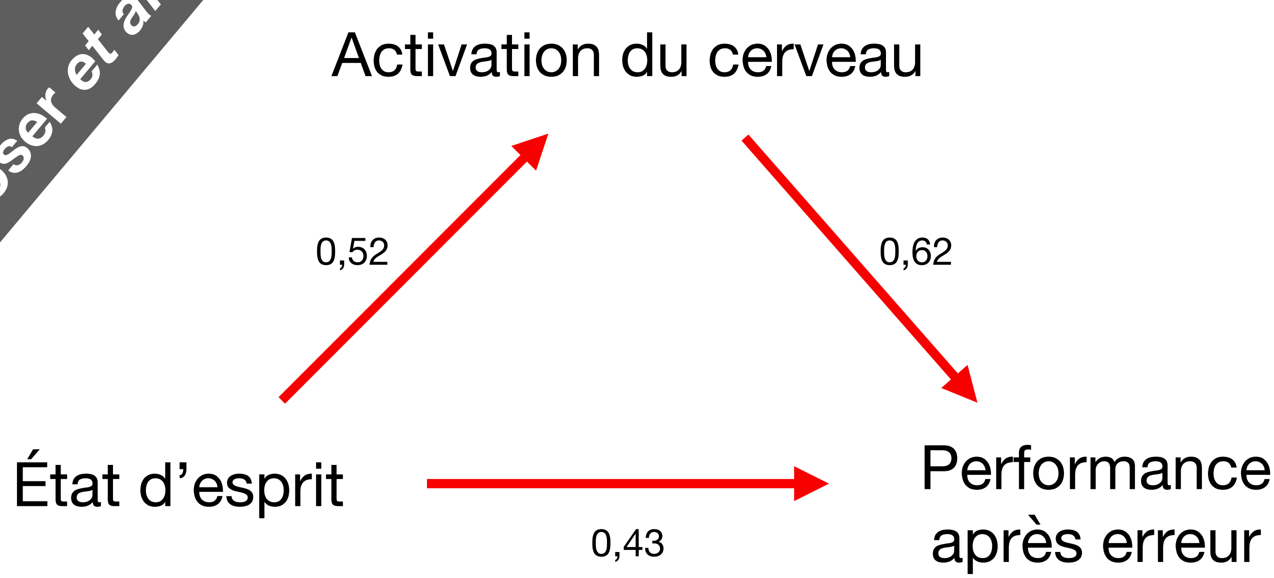
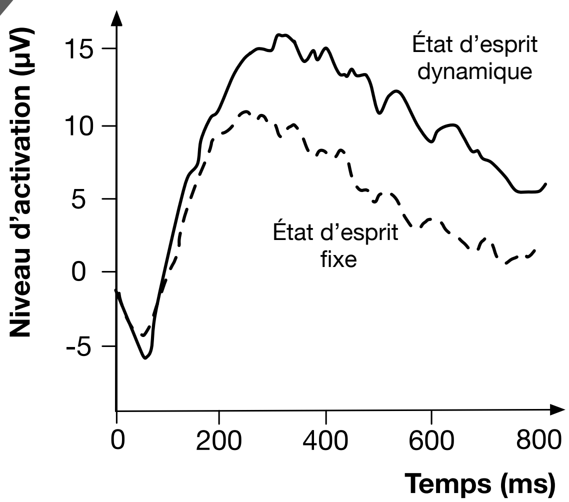
Effet de l'**état d'esprit** sur l'**activité** du cerveau

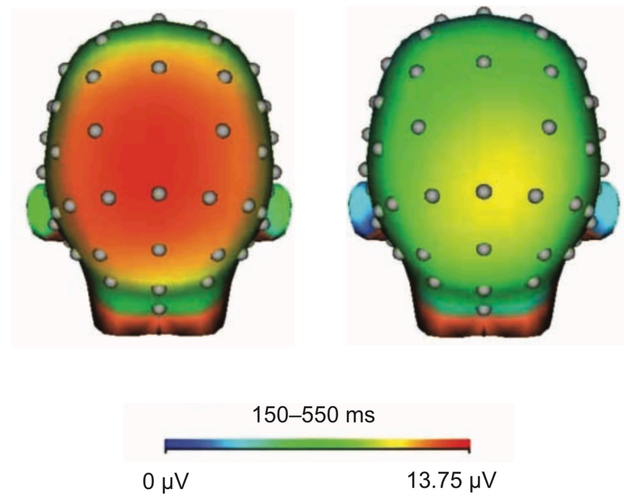
Étude de Moser et al.



Étude de Moser et al.

Après erreur





Étude de Schroder et al.

Biological Psychology 103 (2014) 27–37

Contents lists available at ScienceDirect

Biological Psychology

journal homepage: www.elsevier.com/locate/biopsycho

Mindset induction effects on cognitive control: A neurobehavioral investigation

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ABSTRACT

Messages about how much our abilities can change – or "mindset" messages – affect learning, achievement, and performance interpretations. However, the neurocognitive mechanisms responsible for these effects remain unexplored. To address this gap, we assessed how a mindset induction influenced cognitive control brain activity. Participants were randomly assigned to read that intelligence was either malleable (growth-mindset condition) or immutable (fixed-mindset condition) before completing a reaction-time task while electroencephalogram was recorded. Findings revealed that inducing a growth mindset resulted in enhanced attention to task-relevant stimuli, whereas inducing a fixed mindset enhanced attention to responses. Despite enhanced attention to responses in the fixed mindset group, this attention allocation was unrelated to adaptive performance adjustments. In contrast, the growth mindset induction produced a relatively strong coupling between error-related attention allocation and adaptive post-error performance. These results suggest that growth- and fixed-mindset messages have differential effects on the neural dynamics underlying cognitive control.

1. Introduction

Individuals are exposed to different messages about the nature of abilities on an everyday basis, from the teacher comforting a student ("It's OK, not everyone can be a math person"), to the parent praising a child ("You really are a smart boy"), to the sports announcer commenting on a player's skill ("Wow, what a natural!"). These kinds of messages convey implicit assumptions about the malleability of different abilities and may contribute to the attitudes individuals hold about the nature of their abilities – or "mindsets" as they are called in contemporary psychological research. Decades of research suggest that mindsets substantially influence learning, motivation, and achievement (Dweck, 1999, 2006; Gunderson et al., 2013; Mueller & Dweck, 1998; Rattan, Good, & Dweck, 2012). A consistent finding is that a belief in the malleability of self-attributes – a growth mindset – is associated with better performance and perseverance, especially when individuals are faced with challenging tasks. Although the psychological and motivational outcomes associated with mindsets are well understood, researchers know relatively little about the neurocognitive processes that mediate the impact of mindsets on achievement outcomes. In this study, we examined how standard mindset inductions (messages about abilities) influence cognitive control.

1.1. Mindsets/implicit theories

People generally hold one of two beliefs (or "mindsets")[2] about the malleability of self-attributes such as intelligence: the "growth mindset" construes intelligence as malleable and improvable; the "fixed mindset" understands intelligence as an absolute entity that cannot be changed (Dweck, Chiu, & Hong, 1995). A large body of literature has documented that these different mindsets lead to different attributions, goals, and experiences of performance situations (see Burnette, O'Boyle, VanEpps, Pollack, & Finkel, 2013 for a review). For instance, individuals who hold the growth mindset believe that successful performance is largely driven by effort, whereas fixed-minded individuals believe success is determined mostly by natural ability (Dweck, 2006). These basic assumptions of where ability comes from are thought to bias individuals' goals for achievement. Whereas growth-minded individuals typically focus on learning to *master* a given task,

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[2] Note that we consider the terms "mindsets" and "implicit theories" as interchangeable. A growth mindset corresponds to an "incremental theory" whereas a fixed mindset corresponds to an "entity theory".

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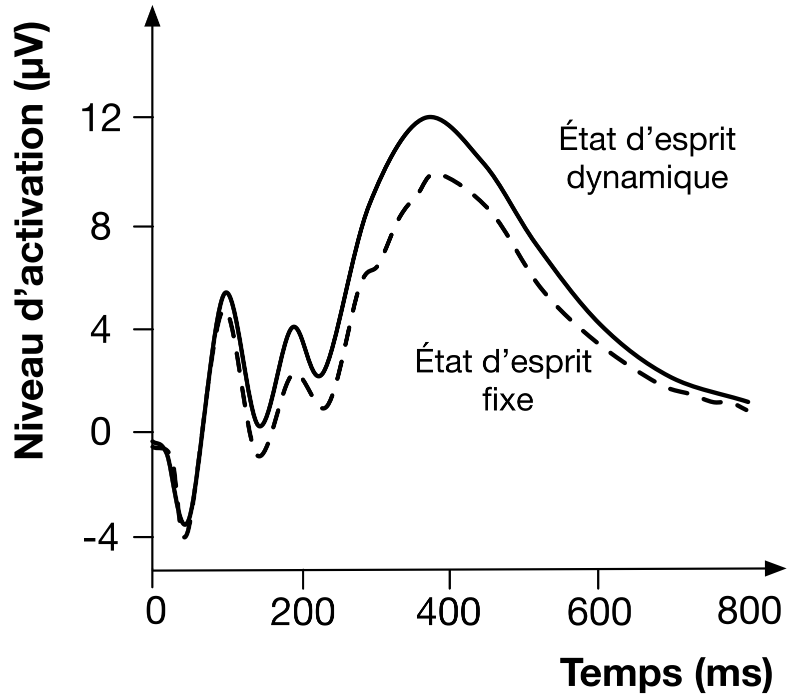
Effet de la lecture d'un **texte** (dynamique vs fixe) sur l'activité du cerveau

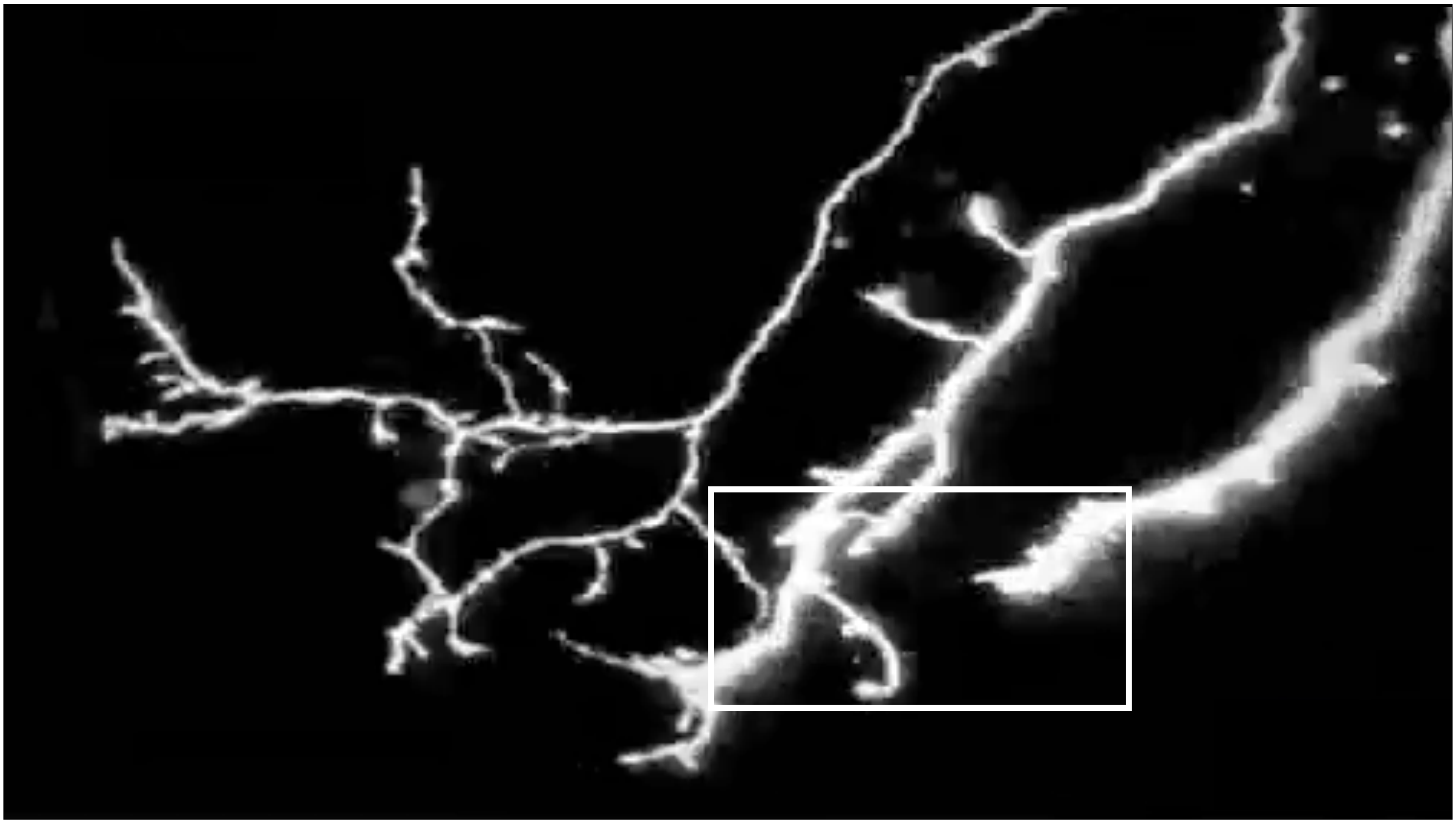
Étude de Schroder et al.



Idée 1
Cultiver un état d'esprit dynamique

Comment ?

Stratégie 1
Connaître la notion de neuroplasticité



15

https://youtu.be/36IA8Y8mRgE

16

Idée 1
Cultiver un état d'esprit dynamique

Comment ?

Stratégie 1
Connaître la notion de neuroplasticité

Stratégie 2
Fournir des rétroactions compatibles avec un état d'esprit dynamique

Quoi éviter ?

Succès = talent	Succès = Effort
« Bravo pour votre excellente performance. Vous êtes vraiment bon ! Vous avez du talent ! »	« Bravo pour votre excellent résultat ! Vous voyez, en travaillant fort, on obtient des résultats ! »
« Ne vous en faites pas. Ce n'est pas tout le monde qui peut être bon dans ce domaine. Vous avez d'autres forces ! »	« Ne vous inquiétez pas. Vous allez y arriver si vous continuez à faire des efforts. »

Inspirée de Dweck (2015)

Quoi dire ?

Succès = processus (impliquant effort **et** stratégies)

« L'objectif, ce n'est pas de tout réussir d'un coup. L'objectif est de développer sa compréhension étape par étape. Que pouvez-vous essayer d'autre ? »

« Si vous vous surprenez à dire "je ne suis pas bon", ajoutez le mot "encore" à votre phrase. »

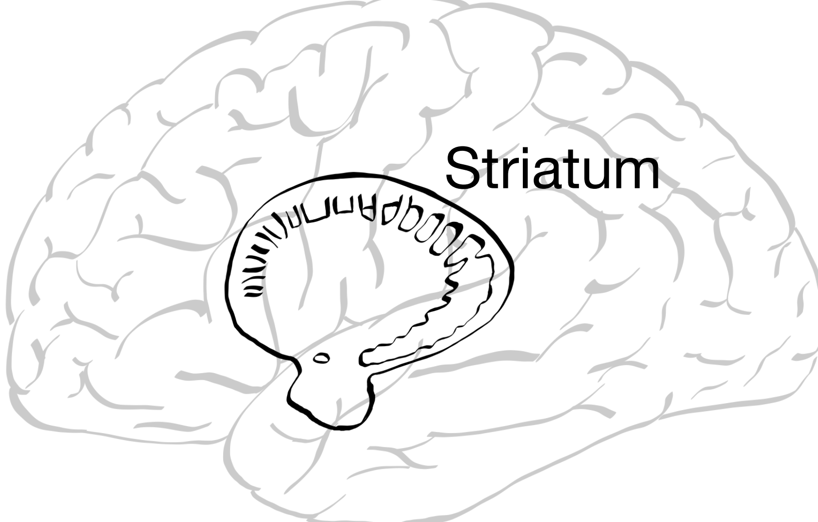
« La sensation que vous ressentez quand une tâche est difficile, c'est la sensation de votre cerveau qui se développe ! »

« Bravo pour votre excellent résultat. Vous avez travaillé fort, vous avez amélioré vos stratégies d'étude et, depuis, vous ne cessez de vous améliorer ! »

Inspiré de Dweck (2015)

Idée 2

Bénéfice



Étude de Wilkinson et al.


Human Brain Mapping 35:5106–5115 (2014)

Probabilistic Classification Learning With Corrective Feedback is Associated With in vivo Striatal Dopamine Release in the Ventral Striatum, While Learning Without Feedback is Not

Leonora Wilkinson,[1] Yen Foung Tai,[2] Chia Shu Lin,[2] David Albert Lagnado,[3] David James Brooks,[2,4] Paola Piccini,[2] and Marjan Jahanshahi[1]*

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[2] *Center for Neuroscience, Division of Experimental Medicine, Department of Medicine, Cyclotron Building, Imperial College London, Hammersmith Campus, London, United Kingdom*
[3] *Department of Psychology, University College London, London, United Kingdom*
[4] *Institute of Clinical Medicine, Aarhus University, Aarhus, Denmark*

Abstract: The basal ganglia (BG) mediate certain types of procedural learning, such as probabilistic classification learning on the 'weather prediction task' (WPT). Patients with Parkinson's disease (PD), who have BG dysfunction, are impaired at WPT-learning, but it remains unclear what component of the WPT is important for learning to occur. We tested the hypothesis that learning through processing of corrective feedback is the essential component and is associated with release of striatal dopamine. We employed two WPT paradigms, either involving learning via processing of corrective feedback (FB) or in a paired associate manner (PA). To test the prediction that learning on the FB but not PA paradigm would be associated with dopamine release in the striatum, we used serial ^{11}C-raclopride (RAC) positron emission tomography (PET), to investigate striatal dopamine release during FB and PA WPT-learning in healthy individuals. Two groups, FB, ($n = 7$) and PA ($n = 8$), underwent RAC PET twice, once while performing the WPT and once during a control task. Based on a region-of-interest approach, striatal RAC-binding potentials reduced by 13–17% in the right ventral striatum when performing the FB compared to control task, indicating release of synaptic dopamine. In contrast, right ventral striatal RAC binding non-significantly increased by 9% during the PA task. While differences between the FB and PA versions of the WPT in effort and decision-making is also relevant, we conclude striatal dopamine is released

Leonora Wilkinson and Yen Foung Tai contributed equally to this work.

Leonora Wilkinson is currently at Behavioral Neurology Unit, National Institute for Neurological Disorders and Stroke, 10 Center Drive, Bethesda, Maryland

Contract grant sponsor: Medical Research Council (UK) core program

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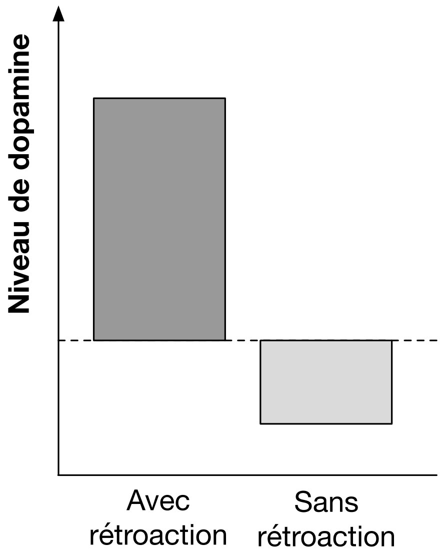
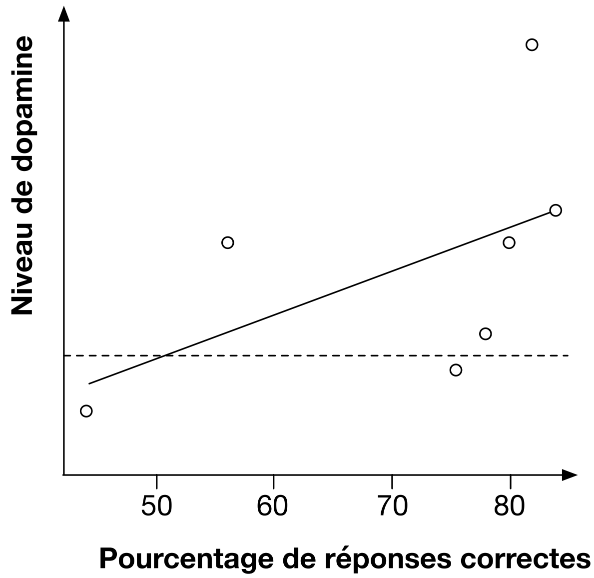
Effet de la **rétroaction** sur le cerveau et le relâchement de **dopamine**

Étude de Wilkinson et al.

Dans le striatum

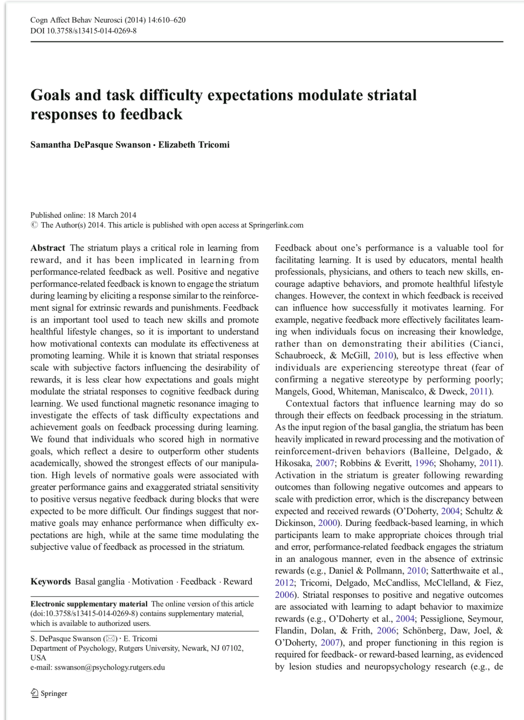




Rétroaction **positive** ⇒ **dopamine** ↑

⇒ sentiment de **plaisir**/satisfaction ↑

Étude de DePasque et al.



Cogn Affect Behav Neurosci (2014) 14:610–620
DOI 10.3758/s13415-014-0269-8

Goals and task difficulty expectations modulate striatal responses to feedback

Samantha DePasque Swanson · Elizabeth Tricomi

Published online: 18 March 2014

Abstract The striatum plays a critical role in learning from reward, and it has been implicated in learning from performance-related feedback as well. Positive and negative performance-related feedback is known to engage the striatum during learning by eliciting a response similar to the reinforcement signal for extrinsic rewards and punishments. Feedback is an important tool used to teach new skills and promote healthful lifestyle changes, so it is important to understand how motivational contexts can modulate its effectiveness at promoting learning. While it is known that striatal responses scale with subjective factors influencing the desirability of rewards, it is less clear how expectations and goals might modulate the striatal responses to cognitive feedback during learning. We used functional magnetic resonance imaging to investigate the effects of task difficulty expectations and achievement goals on feedback processing during learning. We found that individuals who scored high in normative goals, which reflect a desire to outperform other students academically, showed the strongest effects of our manipulation. High levels of normative goals were associated with greater performance gains and exaggerated striatal sensitivity to positive versus negative feedback during blocks that were expected to be more difficult. Our findings suggest that normative goals may enhance performance when difficulty expectations are high, while at the same time modulating the subjective value of feedback as processed in the striatum.

Keywords Basal ganglia · Motivation · Feedback · Reward

Electronic supplementary material The online version of this article (doi:10.3758/s13415-014-0269-8) contains supplementary material, which is available to authorized users.

S. DePasque Swanson (✉) · E. Tricomi
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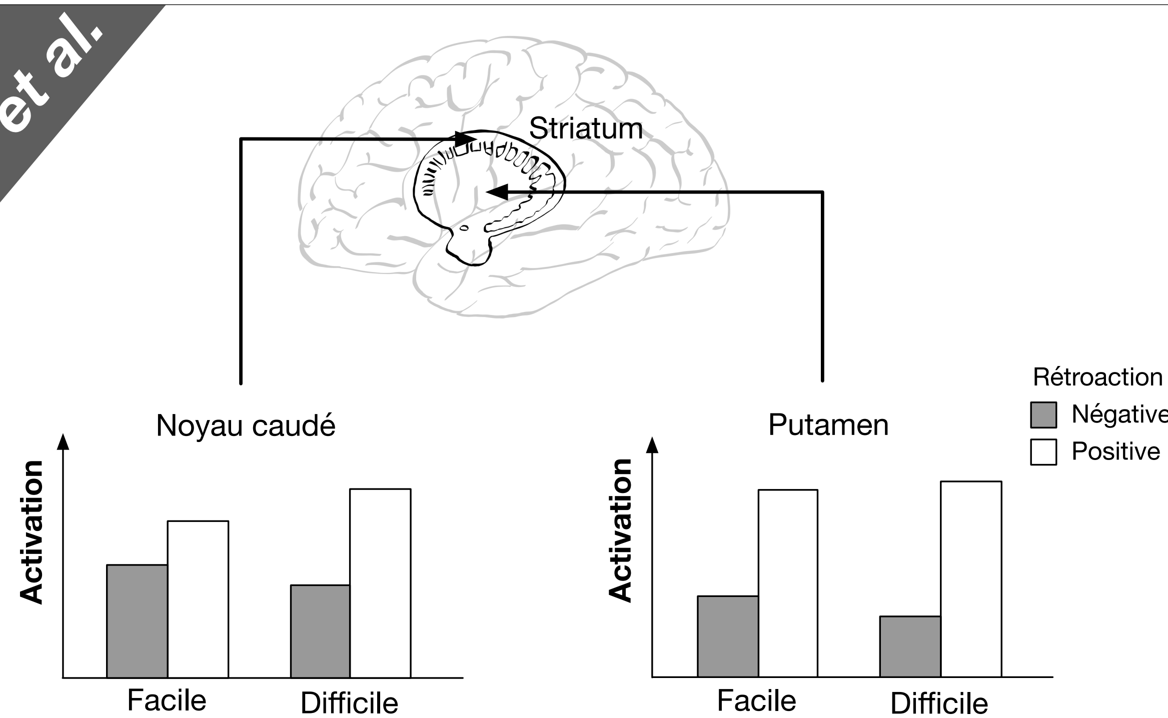
Feedback about one's performance is a valuable tool for facilitating learning. It is used by educators, mental health professionals, physicians, and others to teach new skills, encourage adaptive behaviors, and promote healthful lifestyle changes. However, the context in which feedback is received can influence how successfully it motivates learning. For example, negative feedback more effectively facilitates learning when individuals focus on increasing their knowledge, rather than on demonstrating their abilities (Cianci, Schaubroeck, & McGill, 2010), but is less effective when individuals are experiencing stereotype threat (fear of confirming a negative stereotype by performing poorly; Mangels, Good, Whiteman, Maniscalco, & Dweck, 2011).

Contextual factors that influence learning may do so through their effects on feedback processing in the striatum. As the input region of the basal ganglia, the striatum has been heavily implicated in reward processing and the motivation of reinforcement-driven behaviors (Balleine, Delgado, & Hikosaka, 2007; Robbins & Everitt, 1996; Shohamy, 2011). Activation in the striatum is greater following rewarding outcomes than following negative outcomes and appears to scale with prediction error, which is the discrepancy between expected and received rewards (O'Doherty, 2004; Schultz & Dickinson, 2000). During feedback-based learning, in which participants learn to make appropriate choices through trial and error, performance-related feedback engages the striatum in an analogous manner, even in the absence of extrinsic rewards (e.g., Daniel & Pollmann, 2010; Satterthwaite et al., 2012; Tricomi, Delgado, McCandliss, McClelland, & Fiez, 2006). Striatal responses to positive and negative outcomes are associated with learning to adapt behavior to maximize rewards (e.g., O'Doherty et al., 2004; Pessiglione, Seymour, Flandin, Dolan, & Frith, 2006; Schönberg, Daw, Joel, & O'Doherty, 2007), and proper functioning in this region is required for feedback- or reward-based learning, as evidenced by lesion studies and neuropsychology research (e.g., de

Effet de la **rétroaction positive** sur le cerveau

Étude de DePasque et al.



Activation du système de **récompense**

Réussite ⇒ rétroaction positive ↑ ⇒ striatum ↑ ⇒ dopamine ↑ ⇒ sentiment de plaisir/satisfaction ↑ ⇒ **motivation**

Étude de Garon-C. et al.


CHILD DEVELOPMENT

Child Development, January/February 2016, Volume 87, Number 1, Pages 165–175

Intrinsic Motivation and Achievement in Mathematics in Elementary School: A Longitudinal Investigation of Their Association

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Frank Vitaro
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Institute of Genetic, Neurobiological, and Social Foundations of Child Development, Tomsk State University and Department of Pediatrics and Psychology, Université de Montréal and University College Dublin

This study examined the associations between intrinsic motivation and achievement in mathematics in a sample of 1,478 Canadian school-age children followed from Grades 1 to 4 (ages 7–10). Children self-reported their intrinsic motivation toward mathematics, whereas achievement was measured through direct assessment of mathematics abilities. Cross-lagged models showed that achievement predicted intrinsic motivation from Grades 1 to 2, and from Grades 2 to 4. However, intrinsic motivation did not predict achievement at any time. This developmental pattern of association was gender invariant. Contrary to the hypothesis that motivation and achievement are reciprocally associated over time, our results point to a directional association from prior achievement to subsequent intrinsic motivation. Results are discussed in light of their theoretical and practical implications.

The question as to whether intrinsic motivation predicts academic achievement has attracted much attention among education researchers and school professionals (Reeve, 2002). Under self-determination theory (SDT), intrinsic motivation refers to being engaged in an activity because of one's inherent interest and pleasure for this activity rather than due to external contingencies (Ryan & Deci, 2000). It is conceptualized as a natural catalyst for learning and achievement (Gottfried, 1985, 1990; Ryan & Deci, 2009).

This research was supported by grants from the Québec Ministry of Health, the Fonds Québécois de la Recherche sur la Société et la Culture (FQRSC), the Social Science and Humanities Research Council (SSHRC), the Canadian Institutes for Health Research (CIHR), and Grant 11.G34.31.003 from the Russian Federation. Michel Boivin is supported by the Canada Research Chair Program. We are grateful to the parents of the children participants to the Québec Longitudinal Study of Child Development (QLSCD). We thank the Québec Institute of Statistics, Mireille Jetté, and the GRIP staff members for data collection and management, and Bei Feng and Hélène Paradis for assistance with statistical analyses.

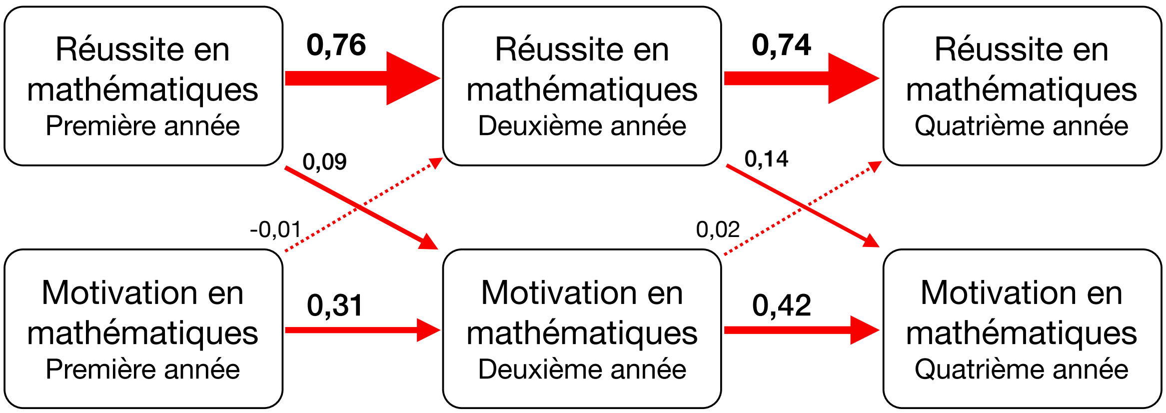
Correspondence concerning this article should be addressed to Michel Boivin, CRC in Child Development, École de psychologie, Université Laval, Québec, Canada G1K 7P4. Electronic mail may be sent to michel.boivin@psy.ulaval.ca.

[Correction added after online publication on November 9, 2015: an author's name was corrected from "Jean Séguin" to "Jean R. Séguin."]

0009-3920/2016/8701-0014
DOI: 10.1111/cdev.12458

Motivation cause réussite ou **réussite** cause motivation ?

Étude de Garon-C. et al.



La **réussite** cause la **motivation !**

Idée 2

Favoriser la réussite et l'augmentation de dopamine

Comment ?

Stratégie 1

Fournir de la rétroaction positive

Rétroaction positive

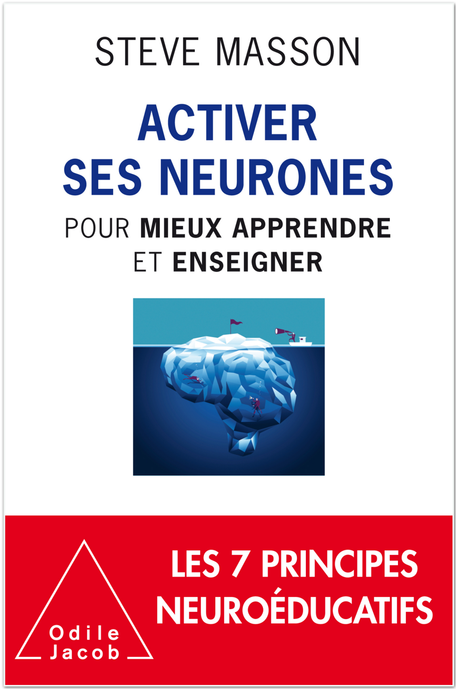
Fréquente et idéalement immédiate

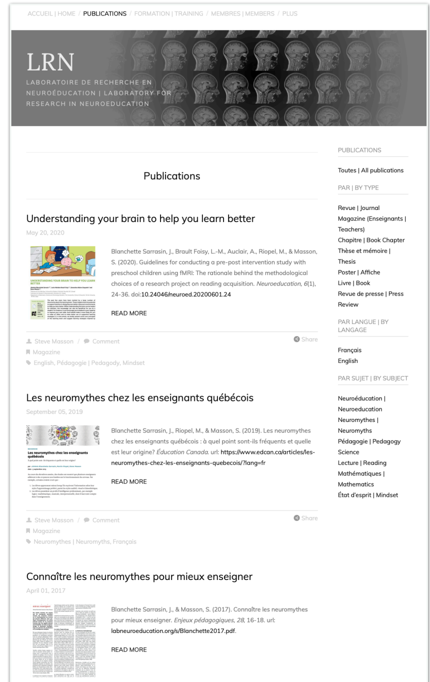
Idée 2
Favoriser la réussite et l'augmentation de dopamine

Comment ?

Stratégie 1
Fournir de la rétroaction positive

Stratégie 2
Utiliser des principes issus de la recherche





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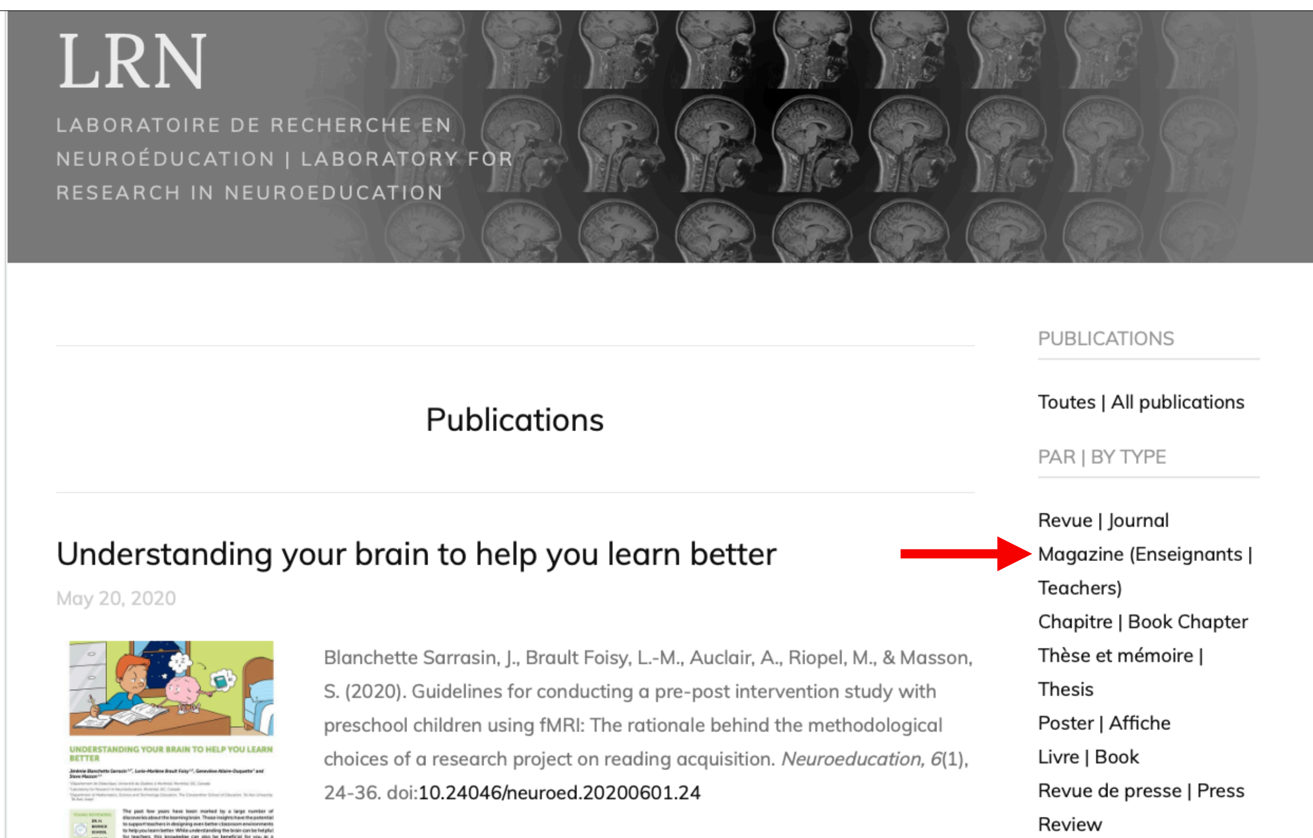


Idée 2

Favoriser la réussite et l'augmentation de dopamine

Comment ?

Stratégie 1

Fournir de la rétroaction positive

Stratégie 2

Utiliser des principes issus de la recherche

Stratégie 3

Tâches ni trop faciles ni trop difficiles

Étude de **Wilson et al.**

nature COMMUNICATIONS

ARTICLE

https://doi.org/10.1038/s41467-019-12552-4 OPEN

The Eighty Five Percent Rule for optimal learning

Robert C. Wilson[1,2*], Amitai Shenhav[3,4], Mark Straccia[5] & Jonathan D. Cohen[6]

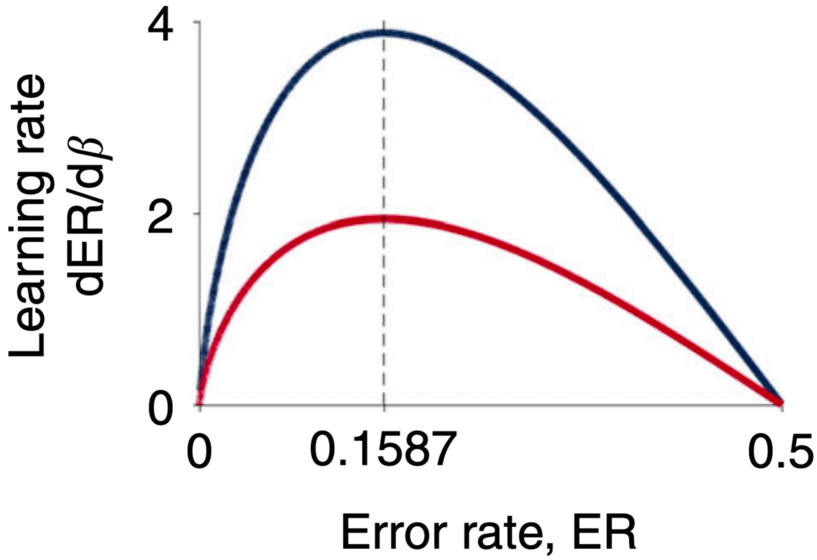
Researchers and educators have long wrestled with the question of how best to teach their clients be they humans, non-human animals or machines. Here, we examine the role of a single variable, the difficulty of training, on the rate of learning. In many situations we find that there is a sweet spot in which training is neither too easy nor too hard, and where learning progresses most quickly. We derive conditions for this sweet spot for a broad class of learning algorithms in the context of binary classification tasks. For all of these stochastic gradient-descent based learning algorithms, we find that the optimal error rate for training is around 15.87% or, conversely, that the optimal training accuracy is about 85%. We demonstrate the efficacy of this 'Eighty Five Percent Rule' for artificial neural networks used in AI and biologically plausible neural networks thought to describe animal learning.

[1] Department of Psychology, University of Arizona, Tucson, AZ, USA. [2] Cognitive Science Program, University of Arizona, Tucson, AZ, USA. [3] Cognitive, Linguistic, & Psychological Sciences, Brown University, Providence, RI, USA. [4] Brown Institute for Brain Science, Brown University, Providence, RI, USA. [5] Department of Psychology, UCLA, Los Angeles, CA, USA. [6] Princeton Neuroscience Institute, Princeton University, Princeton, NJ, USA.
*email: bob@arizona.edu

NATURE COMMUNICATIONS | (2019)10:4646 | https://doi.org/10.1038/s41467-019-12552-4 | www.nature.com/naturecommunications 1

Effet du **taux de réussite** sur l'apprentissage

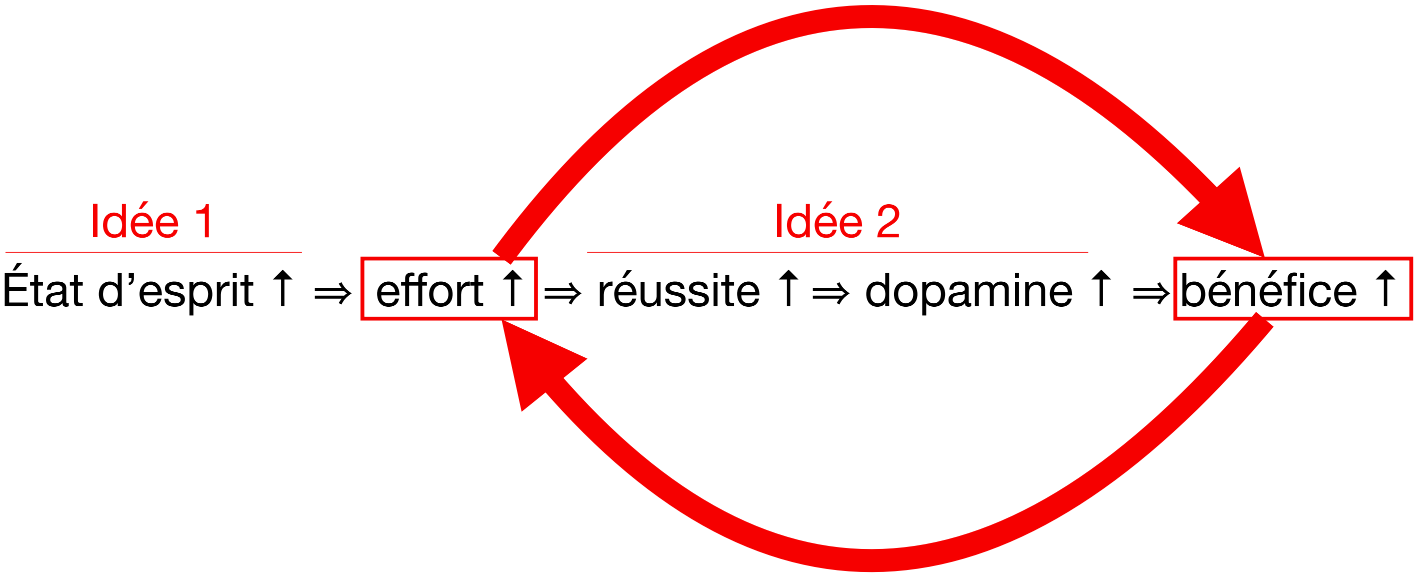
Étude de Wilson et al.



Taux d’erreur optimal : 15,9%

Taux de réussite optimal : 84,1%

Synthèse



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Original article

The matter of motivation: Striatal resting-state connectivity is dissociable between grit and growth mindset

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Abstract

The current study utilized resting-state functional magnetic resonance imaging (fMRI) to examine how two important non-cognitive skills, grit and growth mindset, are associated with cortico-striatal networks important for learning. Whole-brain seed-to-voxel connectivity was examined for dorsal and ventral striatal seeds. While both grit and growth mindset were associated with functional connectivity between ventral striatal and bilateral prefrontal networks thought to be important for cognitive-behavioral control. There were also clear dissociations between the neural correlates of the two constructs. Grit, the long-term perseverance towards a goal or set of goals, was associated with ventral striatal networks including connectivity to regions such as the medial prefrontal and rostral anterior cingulate cortices implicated in perseverance, delay and receipt of reward. Growth mindset, the belief that effort can improve talents, notably intelligence, was associated with both ventral and dorsal striatal connectivity with regions thought to be important for error-monitoring, such as dorsal anterior cingulate cortex. Our findings may help construct neurocognitive models of these non-cognitive skills and have critical implications for character education. Such education is a key component of social and emotional learning, ensuring that children can rise to challenges in the classroom and in life.

Key words: resting-state fMRI; grit; growth mindset; character education; functional connectivity

Introduction

High-stakes testing epitomizes the long-standing attribution of cognitive skills to success. This focus has monopolized students' classroom time and left little resources for development of non-cognitive skills (e.g. perseverance, mindset) critical to social and emotional learning (SEL). However, a growing body of evidence associates non-cognitive skills with academic outcomes (Blackwell *et al.*, 2007; Duckworth *et al.* , 2007), and thus has begun to gain traction in academic policy. Emerging alongside the SEL movement's growing popularity come a number of gaps in the evidence needed to feasibly embark on widespread integration in educational practice. First, studies have shown that a number of non-cognitive skills can be developed (Cunha and Heckman, 2008), but their underlying mechanisms have yet to be explored to elucidate how they interact with cognitive traits. Second, SEL, non-cognitive skills and character education

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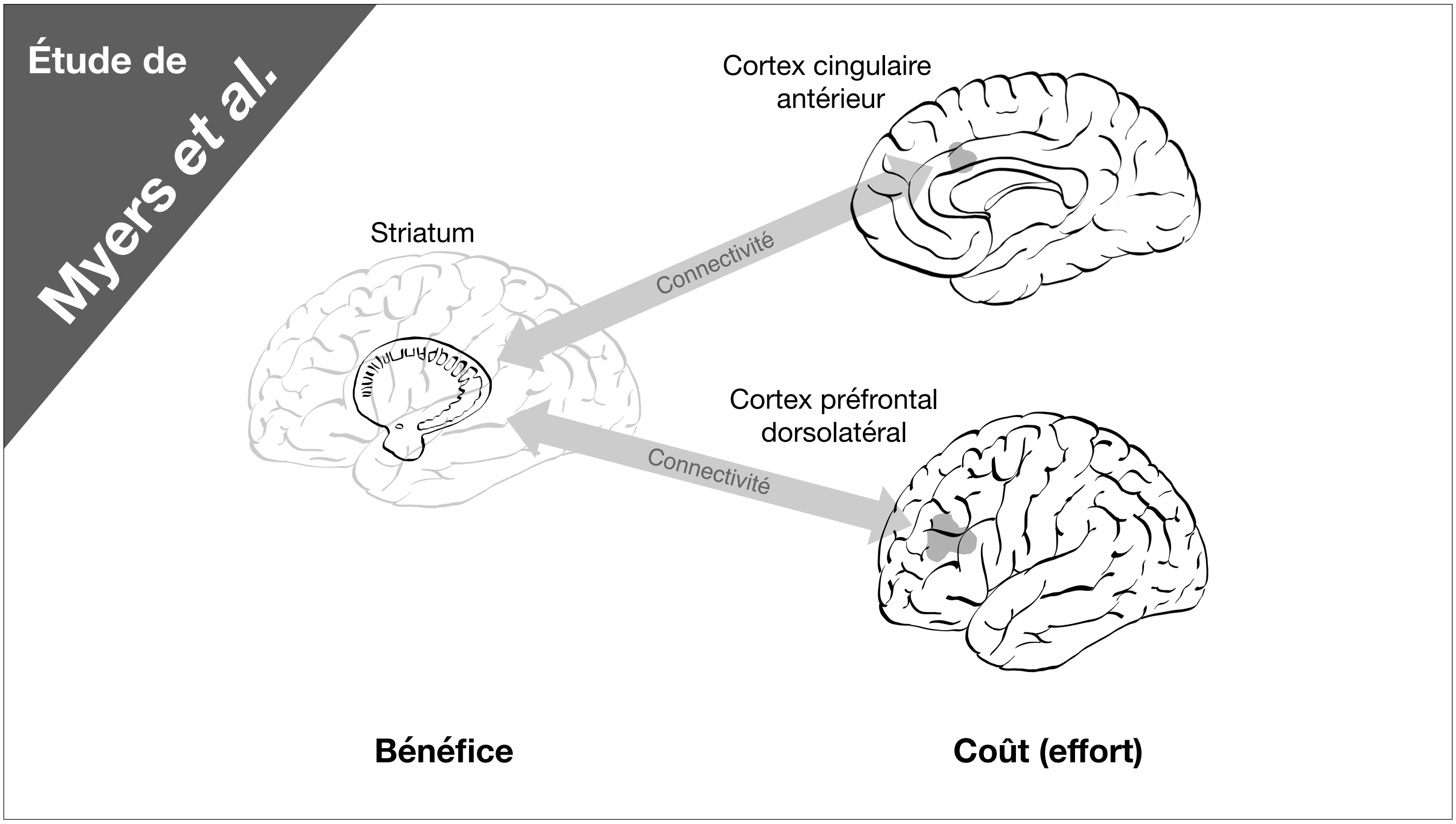
Effet de l'**état d'esprit** sur la **connectivité** fonctionnelle



Idée 1
Cultiver un état d'esprit dynamique

- Connaître la notion de neuroplasticité
- Fournir des rétroactions compatibles avec un état d'esprit dynamique

Idée 2
Favoriser la réussite et l'augmentation de dopamine

- Fournir de la rétroaction positive
- Utiliser des principes issus de la recherche
- Proposer des tâches ni trop faciles ni trop difficiles

Comprendre le **cerveau** pour favoriser la **motivation**