YEARBOOK

2019

institut
cognition

INSTITUT
CARNOT
cognition

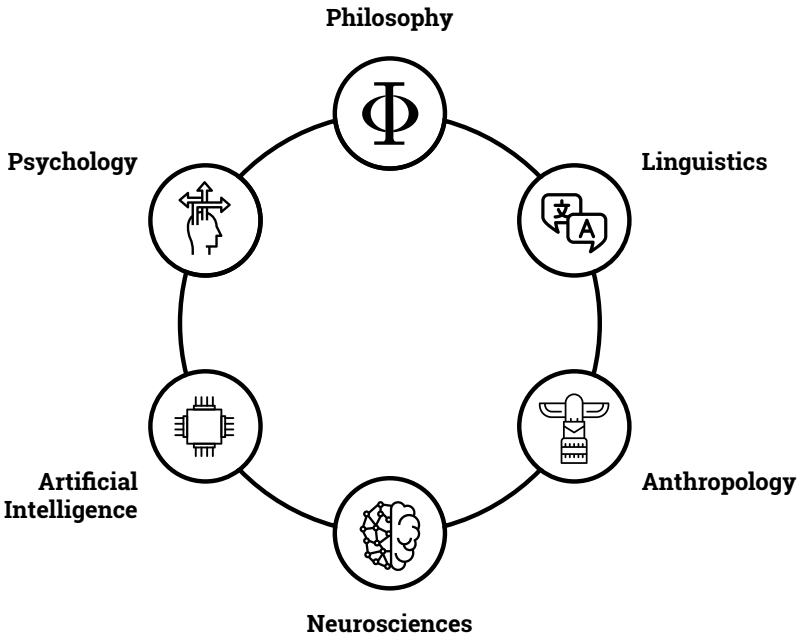
YEARBOOK

2019

institut
cognition

INSTITUT
CARNOT
cognition

Summary



EDITORIAL

Cognitive sciences and technologies, an asset for competitive innovation

The Cognition Institute (winner of the «Carnot» label in 2020) has been driven since its creation in 2016 by two challenges: first is the scientific structure of the field and second is the significant increase in contractual research. The ambition of the «Carnot» Cognition Institute is to be the single entry point for cognition knowledge/activity/innovation for the socio-economic world.

This first «Yearbook» or «Highlights» of 2019 illustrates these two fundamental challenges and some of the progress that has been made this year.

Scientific research

Until 2018, the Cognition Institute was structured around three scientific axes: «Cognitive enhancement technologies», «Collective cognition» and «Cognition & language»; based on the recommendations of its COSS (French acronym for Scientific and Strategic Orientation Committee), a fourth axis «Cognitive behavioral assessments» was later introduced to better respond to the technological and societal challenges of tomorrow's France.

Célestin SEDOGBO

Director of the Cognition Institute

The Cognition Institute CoPil (Steering Committee), composed of 22 Directors of constituent Units or their representatives (Isis Truck - CHArt, Roberto Casati - IJN, Daniel Pressnitzer - LSP, Emmanuel Dupoux - LSCP, Emmanuel Mahé - ENSADLab, Yann Coello - SCALab, Charles Lenay - COSTEC, Franck Zenasni - LaPEA, Sophie Rosset - LIMSI, Nicolas Vayatis - Centre BORELLI, Bénédicte Poulain-Charronnat - LEAD, Jérôme Mars - GIPSA Lab, Monica Baciu - LPNC, Noel de Palma - LIG, Nicolas Vibert - CeRCA, Jean-Marc André - IMS, Michel Dayde - IRIT, Claire Rampon - CRCA, Johannes Ziegler - LPC, Laurent Prevot - LPL, Thierry Hasbroucq - LNC, Yannick Esteve - LIA), provides the scientific framework of the Institute.

The Cognition Institute has a permanent full-time staff of 737 and a non-permanent staff of 1,058. The size and structure of the Institute is unprecedented in the history of cognitive sciences in France and probably in Europe.

Research income

In 2019, our (invoiced) income from research contracts and grants amounted to €27 ,000,000, an increase of 4% compared to 2018. This amount included € 3,800,000 of contractual research, or around 14% of the total. The income of 27M € also included 9.9M € of collaborative research grants involving the socio-economic world.

Despite this, the theme of cognition remains unknown to a large number of socio-economic actors. And for those already aware, its added value remains difficult to measure since it is a theme at the frontier of human and social sciences.

The partnership relationship

Contract research is one of the major indicators of vitality in the socio-economic world. The €3,000,000 in 2019 contract revenue was generated by 126 contracts with 110 companies, including 33 large national companies, 12 national ETIs, 53 national SMEs/VSEs and 12 foreign companies (including large companies, ETIs, SMEs/VSEs and others).

The intention of this 2019 Yearbook is to bear witness to our intense scientific activity through a few highlights from the four scientific areas, and to illustrate the wealth of relations with the industrial world through concrete examples.

On behalf of the CoPil and on my own behalf, I wish you all happy reading.

Cognitive enhancement technologies

«Cognitive enhancement» is a cross-cutting field of research at the frontier between human-computer interaction, psychology, ergonomics and neuroscience. It aims to create innovative interactions that help, supplement, or increase the capacities for human processing of information. The creation of such interactions comes from the ability to measure in real time human information processing and the cognitive states of users.

The development of new interactions makes it possible, for example, to design innovative uses, «affective» conversational agents or adaptive interfaces according to a user's profile or behavior.

Véronique Lespinet Najib (IMS) and Éric Castet (LPC) - Scientific Coordinators

Contactless Cardiography

Scientific background

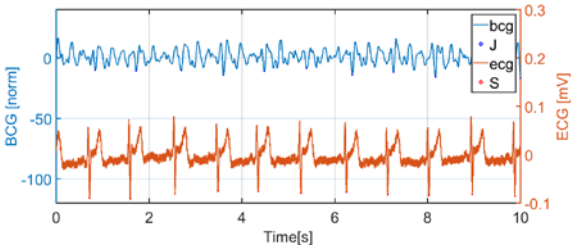
Ballistocardiography is a non-invasive measure of cardiac activity. It is based on the following phenomenon: during the cardiac cycle, left ventricular systole ejects blood from the heart through the aorta. The recoil force of this ejection generates a mechanical wave that travels through the sleeping human body to the mattress and instantly deforms the support.

Method

As part of a clinical pre-study, we measured this mechanical wave using accelerometers placed on mattress covers during 20-minute naps in about 30 adults. Signal processing algorithms modelled the signal and detected heartbeats with a sensitivity and specificity of over 95%. These recordings were synchronised with those made from an electrocardiogram.

Results

It was thus demonstrated in the laboratory that it is possible to measure the heart rate, respiratory rate and motor activity of hospitalised individuals, without any contact with the patient and in a completely automatic way. Events such as cardiac arrhythmias and sleep apnea were also detected with this method.



Ballistocardiogram (BCG) synchronised with an electrocardiogram (ECG)

General discussion

We achieve similar results on seated individuals by placing the sensors in a cushion. This method can therefore apply to the study of pilot vigilance for railway, aeronautical and automobile companies. Indeed, many studies have shown that heart rate variability is correlated with cognitive state and alertness. Further, the non-invasive nature of the device makes it possible to be integrated for e.g., the long-term monitoring of drivers.

For further information
---
https://www.researchgate.net/profile/Guillaume_Cathelain/research

Attentional Control of Hearing Aids

Laboratoire des Systèmes Perceptifs

Scientific background

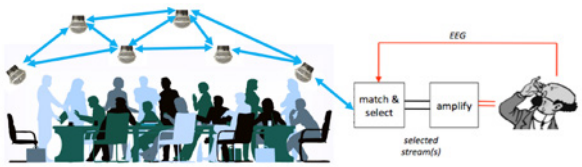
Untreated hearing loss in the EU is estimated to cost more than 185 billion Euros each year, more than the entire EU budget. Hearing aid function, limited by poor performance in noisy environments, can be boosted with microphone arrays and deep-learning based algorithms, but only if the user can effectively control them. This project develops attentional and cognitive control methods that minimize behavioural and cognitive load on the user.

Method

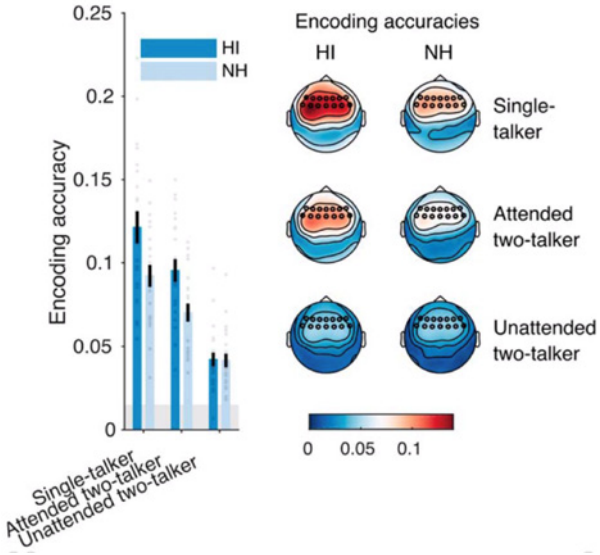
Over the past 4 years we have used surface electrodes (e.g., in the ear canal) together with decoding algorithms to derive a control signal from the user's brain state (H2020 project COCOHA, cocoha. org). Current plans are to include audio-visual (AV) and gaze cues, along with recent deep-learning theories and sound separation algorithms augmented with AV cues to create a model of AV environmental sources and AV attention to them.

Results

A real-time demo, including an ad- hoc microphone array under control of a decoding algorithm fed by signals from an EEG cap, demonstrated the feasibility of this concept. Advances in key elements are documented in the publications (link below).



Cognitive control allows the user to steer sophisticated acoustic processing



Attentional signals are actually enhanced in hearing impaired (HI) subjects compard to non-hearing impaired (NH)

General discussion

Control is a major bottleneck in the development of effective solutions for the hearing impaired. Successful development of cognitive/ attentional control could be a key enabling technology.

For further information

See publication list at www.cocoha.org

Adult visual cortex plasticity

Laboratoire des Systèmes Perceptifs

Scientific background

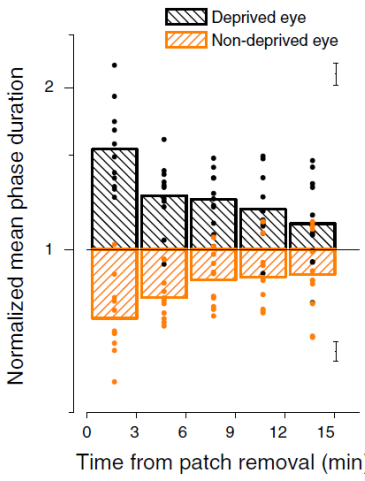
During development, within the so called critical period (6-7 years old in humans), the plastic potential of the visual cortex is maximal. Afterwards the visual cortex is thought to become hard-wired or resilient to change. A perfect example is the disorder amblyopia, the treatment of which relies on visual cortex plasticity and is ineffective in adulthood. We have now revealed a new form of adult visual cortical plasticity in humans and exploited it to develop new therapies for amblyopia.

Method

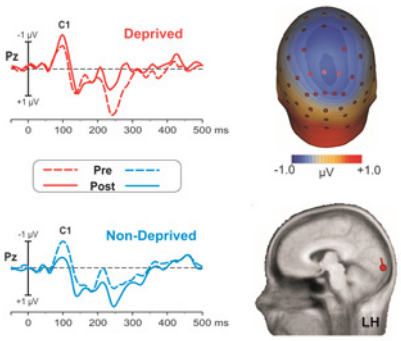
We investigated the effect of short-term (2 to 2.5 hours) monocular deprivation (MD) dominance and visual cortical activity (EEG, fMRI, MRS) in adult humans. Ocular dominance was meausured based on a behavioral test of competition between use of left and right eyes.

Results

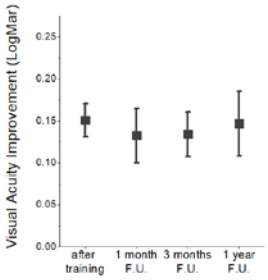
Short-term MD in adult humans unexpectedly shifted ocular dominance to the deprived eye, reflecting visual cortex plasticity. The deprived eye signal was boosted at the perceptual and neural level. In the long term (1 year), short-term deprivation of the amblyopic eye and physical exercise, induced recovery of visual function in adult amblyopic patients.



After 2.5 h of MD in adults, perceptual dominance of the deprived eye is immediately increased and remains increased for at least 15 minutes.



The amplitude of the earliest component of the visual evoked potential is altered by short-term MD as seen by the solid line (post deprivation) surpassing the dotted line (pre deprivation) only in the deprived eye (peak labelled C1).



Visual acuity improvement in adult amblyopic patients after 4 weeks of training (2h occlusion of the amblyopic eye + physical exercise)

General discussion

The adult human visual cortex retains a degree of experience-dependent plasticity higher than previously thought, which can be exploited for rehabilitation of visual diseases.

For further information

Lunghi C, Burr DC, Morrone C (2011) *Brief periods of monocular deprivation disrupt ocular balance in human adult visual cortex*. Curr Biol 21:R538-9 ; Lunghi C, Berchicci M, Morrone MC, Di Russo F (2015) *Short-term monocular deprivation alters early components of visual evoked potentials*. J Physiol 593:4361–4372 ; Lunghi C, Emir UE, Morrone MC, Bridge H (2015) *Short-Term Monocular Deprivation Alters GABA in the Adult Human Visual Cortex*. Curr Biol 25:1496–1501 ; Lunghi C, Sframeli AT, Lepri A, Lepri M, Lisi D, Sale A, Morrone MC (2019) *A new counterintuitive training for adult amblyopia*. Ann Clin Transl Neurol 6:274–284.

Perceptual strategies of hearing-aid users

Laboratoire des Systèmes Perceptifs

Scientific background

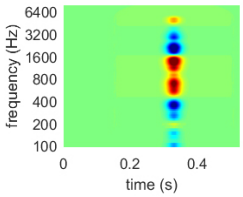
Current hearing aids primarily aim at compensating for the loss of auditory sensitivity through multichannel amplification. However, this restoration is useful only if hearing-impaired listeners can make use of the amplified information despite their cochlear damage. This project builds upon an auditory illusion («bump noise») to measure the perceptual strategies of normal-hearing listeners and hearing-aid users.

Method

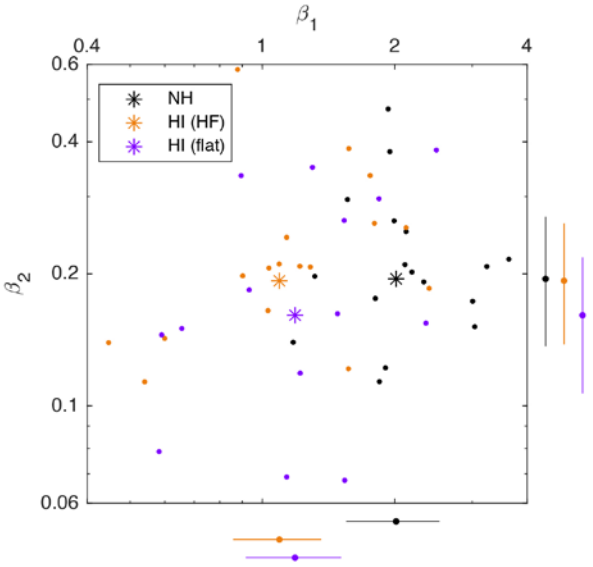
We measured the perceptual weights associated with high-frequency and low-frequency cues by normal- and impaired-hearing listeners during a sound categorization task. Hearing-impaired participants used a frequency-dependent amplification similar to their hearing aid.

Results

Mapping of perceptual strategies revealed that listeners with high-frequency hearing loss rely less than normal- hearing listeners on high-frequency information in speech, even when they are provided with frequency-dependent amplification. This may explain why individuals with high-frequency loss receive only limited benefit from their hearing aid for speech intelligibility.



Typical perceptual map for a normal-hearing categorization. This graphic shows the time-acoustic information most (red and blue regions) influences phonological (speaking) decisions.



Weights of two acoustic cues in a phoneme categorization task for normal-hearing listeners (black) and hearing-aid users (orange and purple). The gap between the two groups indicates that hearing-impaired listeners weighted the acoustic information differently from normal-hearing listeners, even though their audibility deficit was compensated for by a hearing aid.

General discussion

While traditionally viewed as a mere loss of sensitivity, hearing loss also results in a change in speech perception strategies. Together, the results here suggest why current hearing aids are insufficient and encourage new technologies for improving the next generation of devices.

For further information

Varnet L., Langlet C., Lorenzi C., Lazard D. S. et Micheyl C. (2019). *High-Frequency Sensorineural Hearing Loss Alters Cue-Weighting Strategies for Discriminating Stop Consonants in Noise*. Trends in Hearing, 23: 1–18. Varnet L., Knoblauch K., Serniclaes W., Meunier F., Hoen M. (2015). *A Psychophysical Imaging Method Evidencing Auditory Cue Extraction during Speech Perception: A Group Analysis of Auditory Classification Images*. PLoS ONE, 10(3): e0118009. doi: 10.1371/journal.pone.011800.

Prediction of driving ability using classification methods

Scientific background

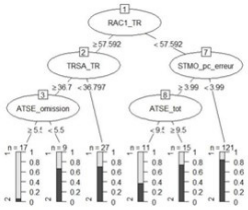
The multifactorial model of driving [1] allows assessment of psychometric functions needed to evaluate conditions necessary for safe driving: information processing speed, reaction time, visual attention capacity and working memory. This study applied supervised classification methods to estimate the predictability of psychometric results compared to results obtained during a driving test.

Method

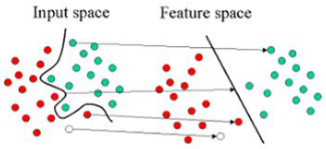
300 participants (112 women and 188 men, aged 20-75) followed the 4 analytical tests of the ACCA battery: selective attention, motor coordination, reaction time, and attention flexibility. In addition, the subjects took a driving test. Three supervised learning algorithms were used: Decision Tree, Support Vector Machine (SVM) and Artificial Neural Network (ANN).

Results

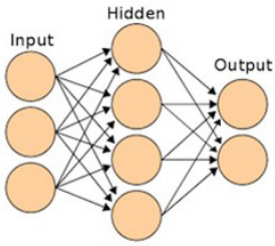
Decision trees were clearly unsatisfactory as they did not allow reliable predictions of outcomes from unexplored data. The SVM and ANN models, on the other hand, provided small error values.



(1) Decision Tree



(2) Support Vector Machine



(3) Artificial neural network

Representation of the three supervised learning algorithms used A

General discussion

Results indicated that ANNs (artificial neural networks) are the best approach, correctly classifying 73.2% of individuals (219 out of 300). Close examination of the classification errors showed that ANN models had difficulty detecting unfit drivers. Further work is underway to maximize the sensitivity of classifiers in a broader population.

For further information

Delevoye-Turrell Y., Boitout J., Bobineau C., Vantrepotte Q ., Davin T., Dinca A. et Desenclos I. (2018) *Predicting safe driving abilities using supervised classification methods.* Conference abstract : 6th International Conference on Driver Distraction and Inattention (DDI2018), 15th-17th October 2018, Gothenburg, Sweden

Interaction dynamics in the genesis of tactile signs

Scientific background

Our tactile communication interfaces (Module d'Interaction Tactile - MIT) allow a fundamental study of the coordination mechanisms during the genesis of shared signs. Fundamental questions are the synchronization of interaction dynamics and the emergence of successive "turns of speech".
We compare and analyze the coordination strategies of the test subjects within the framework of exchanges mediated by these devices.

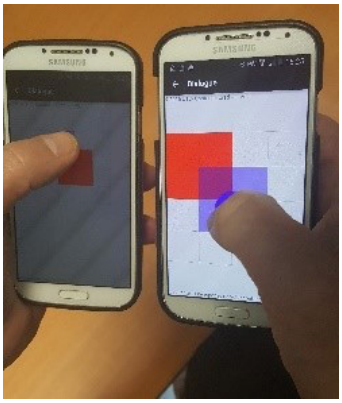
Method

The aim is to study tactile signs are created through a new interface: the Tactile Interaction Module, coupled with smartphones and controlled by our Dialtact software. Studies focused on the interaction between two subjects during negotiation to create a shared sign. This coordination task, conducted entirely in "tactile" mode, allowed us to observe adjustment phases between the partners during turn-taking as well as the signs invented by each pair. The experiments were carried out within the COSTECH Perceptive Supplementation Platform.

Results

The subjects proved capable of constructing a series of shared signs. Synchronous moments of communication were quickly followed by the spontaneous emergence of turn-taking. Signs dedicated to phatic function and meta-coordination were spontaneously created.

The Touch Interaction Module integrates 16 piezoelectric pins. It connects to a smartphone via Bluetooth and can be attached to the back of the smartphone.



Principle of interaction: the movements of a user on the screen of his smartphone activate the touchpads on the partner's smartphone and vice versa.

General discussion

The possibility of tactile interactions radically enriches the communication experience ("tactile dialogue") and the quality of the user's sense of presence.

For further information

Video on https://youtu.be/vXRoZz_K0qM

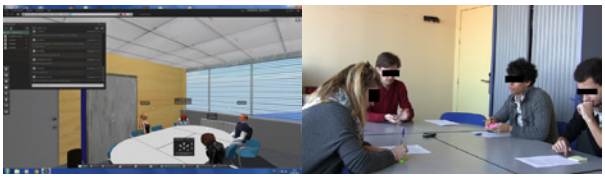
Collective creativity in the environment of multi-user virtual machines

Scientific background

Previous studies have shown that online networked multi-user virtual environments (MUVEs) optimize collective creative performance. However, no studies have investigated individual creative potential in a group brainstorming task. This study explored the following questions: do MUVEs unleash the creative potential of individuals regardless of their initial creative profile? What combination of creative resources promotes fluidity in a brainstorming task?

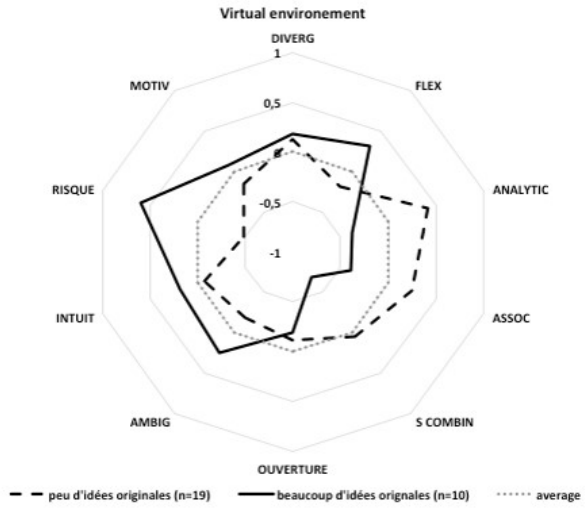
Method

The study involved brainstorming sessions in two conditions: a classic meeting room in a real environment (RE) and a similar meeting room in a virtual environment (VE). 60 public transport users were randomly assigned, in groups of 3, to one of the two conditions and brainstormed on ways to improve mobility in Paris.



Results

At the team level, fluidity and originality were significantly improved by working in EV compared to ER. However, the results suggest that EV does not favor all individuals. EV participants classified as risk-takers were significantly more creative (mastery and originality) than i) those with a similar profile in ER and ii) those with a low risk-taking profile in EV. A similar pattern, but to a lesser extent, was observed for divergent thinking and mental flexibility.



EV: Profiles of the creative potential of participants who have produced few and many original ideas compared to the group average. DIVERG: divergent thinking, FLEX: mental flexibility, ANALYTIC: analytical thinking, ASSOC: associative thinking, S COMBIN: analogical thinking, AMBIG: tolerance of ambiguity, INTUIT: intuitive thinking, Risk: propensity to dare, Motiv: Motivation

General discussion

The virtual environment provides a “liberating” atmosphere that cognitively disinhibits participants with a high scores in risk-taking, divergent thinking and mental flexibility. This disinhibition would be facilitated by openness and intuitive thinking, through a broadening of attention and the activation of more conceptually distant ideas. Thus, the virtual environment appears to promote a feeling of openness and leads, as assessed by the eye-tracking technique, to a widening of attention at the perceptual level.

For further information

Bourgeois-Bougrine S., Richard P., Burkhardt J. M., Frantz B. et Lubart T. (2020). *The expression of users’ creative potential in virtual and real environments: An exploratory study*. Creativity Research Journal, 1-11

SMARTY REA

Scientific background

An objective of health authorities in France is to increase procedures performed in outpatient surgery from 50 to 70%. Hospitals are moving from taking care of patients entirely in-house to a short hospital stay followed by care at home or in appropriate health structures. For more seriously ill patients, intensive care anesthesia for surgery based on a personalized, predictive and preventive approach is desirable.
For this it is imperative to set up a policy based on individual longitudinal follow-up of the person or ILF (Individual Longitudinal Follow-up).

Method

Develop means to secure and organize access to clean, raw and indexed physiological data on the sensorimotor behavior of the surgical and intensive care patient. Then, from the ILS, detect early signs of (pre-)fragility. This requires the development of medical devices to collect these data.
In addition, psychological, biological and socio-economic data should be collected form the patient. These heterogeneous data must be aggregated in a digital cloud for analysis. We have therefore developed several highly automated health data collection devices that allow individual longitudinal monitoring of surgical and intensive care patients.

Results

An original device (“TRIS”) allows quantification of the depth of anesthesia with greater precision than existing devices. It uses a device called “COUVETTE” for improved collection of physiological data and original algorithms patented and published by the Borelli Centre.

General discussion

Predictive, personalized, and participatory paths for the person following an outpatient or intensive care inpatient surgery present several advantages. These are primarily decision aids for professionals based on continuous, on-line identification of weak signals that enable early diagnosis of a pre-fragility or frailty syndrome.

For further information
---
clement.dubost@hotmail.fr
http://centreborelli.cnrs.fr

SMART PILOT

Scientific background

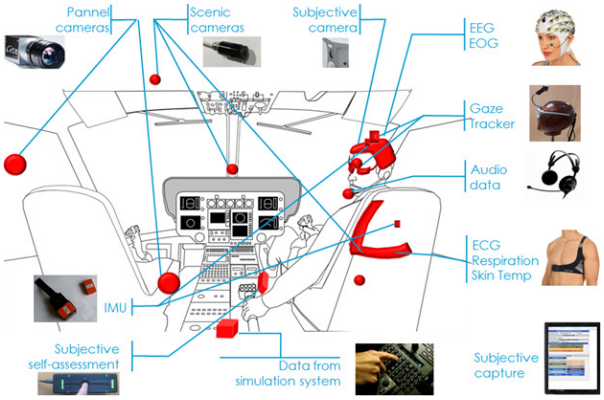
In the human-machine interactions of modern aviation, improved aircraft performance and automation are changing the role of the pilot from manual operator to monitor. The pilot must follow several indicators simultaneously, and the effective capture of visual information is dependent on allocation of the pilot's attention. Mental workload is one of the most important factors influencing the allocation of the pilot's attention resources. In the design of the cockpit human- machine interface, accurate assessment, quantitative classification and prediction of the pilot's mental workload play a critical role.

Method

A model for assessment/prediction of a pilot's mental load through continuous recording and processing of neurophysiological variables will pave the way for monitoring vigilance and vital signs (disabilities). Measurement of these variables in flight has been unrealistic because: the difficulty of equipping pilots busy with complex tasks, the volume of data for recording all variables, and the lack of necessary mathematical tools to combine these heterogeneous variables to estimate the pilot's work- and mental load. From 2015, miniaturization, lower sensor costs and increased data storage have made it possible to continuously measure mental workload in the cockpit. To move from theory to practice, a multidisciplinary team (engineers, ergonomists, neurophysiologists, mathematicians) developed a measurement chain of the pilot's physiological variables to quantitatively describe behavior.

Results

A raw, clean and indexed database of ten simulator pilots is completed. Excavation of this data allowed the development of a preliminary model of the mental load of the pilot, off-line.



General discussion

This trial will now be transformed by expanding our database then refining the model from this larger database so that it can be run online.

For further information
---
dimitri.keriven-serpollet@parisdescartes.fr
http://centreborelli.cnrs.fr

Immersive tele-operation of a humanoid robot

Scientific background

Human-human communication mediated by a humanoid robot brings the following benefits:

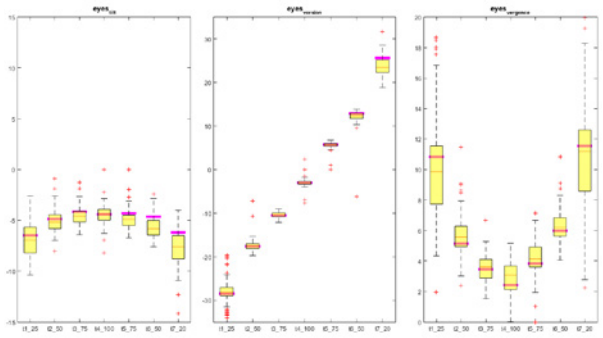
- For the driver: enhanced scene perception and the feeling of presence
- For the robot: learning social behavior ("cognitive gift" for the driver)
- For the interacting partners: benefiting from an efficient service with a low GHG balance sheet

Method

The immersive tele-operation platform allows a driver equipped with a virtual reality helmet including a binocular oculometer to interact with remote partners via a humanoid robot equipped with mobile eye cameras. Other segments of the body involved in social communication are also remotely operated: head, jaw and lip movements, eyelid movements and arm and hand gestures. Together, this reinforces the pilot's feeling of presence in the scene.

The SGCS (stereo gaze-contingent steering) model allows the vergence of the robot's eyes to be controlled by the pilot's own eyes, allowing better depth perception within a distant scene. Additionally, teleoperation enables the robot to acquire social behavior demonstrations, providing situated interaction data that can be exploited by AI algorithms to learn and generate autonomous robotic behavior.

Immersive teleoperation device. Application to the animation of a multiplayer board game.



Control of the robot's eye movements by the driver's eye movements. Quantitative evaluation of elevation, azimuth and vergence setpoint transfers for 7 targets placed in front of the robot.

General discussion

This innovative immersive teleoperation device opens up application and scientific options, simplifying the driver's cognitive behavior and increasing the social presence of the robot as perceived by the partners. These dimensions have been explored in "80 years CNRS 'Robotic presence' project" in collaboration with P. Huguet from LAPSCO-UCA and in the "Collaborative Intelligent Systems" chair in MIAI@Grenoble Alps University.

For further information

---

gerard.bailly@gipsa-lab.fr

http://www.gipsa-lab.fr/recherche/poles-de-plates-formes/plates-formes.php?id_plateforme=98

[1] Cambuzat R. et al, (2018) *Immersive teleoperation of the eye gaze of social robots*, International Symposium on Robotics, Munich: pp. 232-239

De-mosaick for color imaging sensors

Scientific background

Digital cameras consist of a single imaging sensor overlaid with a color filter array, which allows sampling a single color per pixel. A reconstruction step called de-mosaicking is therefore necessary to reconstruct three colors (red, green and blue) from the single color which was captured. This method of color image capture is similar to the human visual system in which randomly arranged LMS cones, whose randomness varies among individuals, form a mosaic on the surface of the retina.
Digital cameras use only a regular arrangement of single imaging sensors.

Method

We propose a statistical learning algorithm for de-mosaicking which can be used on any mosaic, random or regular. Our generic algorithm is not limited to only three color mosaics but can be used for any random arrangement of any number of spectral filters. The secret of our method is to consider a “neighborhood” window of pixels around the pixel in the RAW image for which missing colors are being reconstructed, and to find the appropriate pixel weights to best reconstruct the missing colors. We construct a physical model of image formation on a sensor which we use for learning an inverse solution (Linear solution calculation by Linear Minimum Mean Square Error).

Results

The innovation of the technology are:

- Generic solution which works for any arrangement of color filters in a mosaic.
- Good image reconstruction in terms of image resolution and sharp edges even in low light conditions.
- Low calculation time compared to state-of-the-art methods.

Color Filter Array’s Image

Image reconstructed

General discussion

We are in the process of creating a startup, maturation phase supported by SATT Linksium. We have a demonstrator in Matlab/C++ in the form of a Toolbox/GUI which allows comparing our technology with state-of-the-art methods on metrics ans show the improvement in quality (resolution, Delta E, PSNR) and speed of calculation.

For further information
---
https://youtu.be/oTHvwnVOFtE
david.alleysson@univ-grenoble-alpes.fr

Brain-Computer Interface & Usability

Scientific background

The vast majority of Brain-Computer Interface (BCI) systems are based on an electrophysiological component called P300. Learning to use such a device can be complex and requires high attentional resources. This is why we are studying another type of interface, the size of a virtual keyboard, for degree of usability (effectiveness, efficiency and satisfaction) in order to propose an optimal interface in terms of user experience.

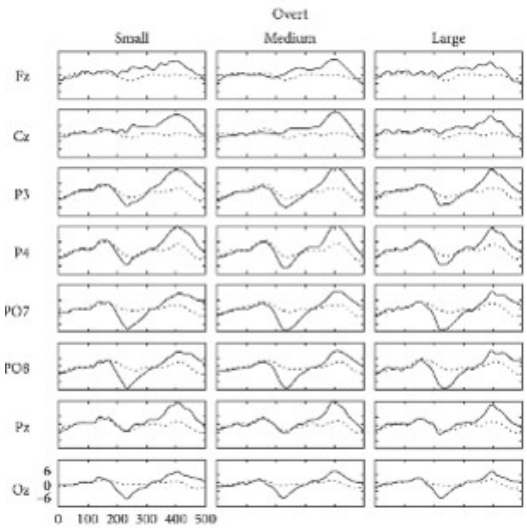
Method

Three sizes of virtual keyboard were tested by each participant. Subjects had to write words or numbers using the BCI. A learning phase of the BCI device was required. We measured several parameters: effectiveness (learning time, number of errors for the written words, shape of the P300s); efficiency (cognitive load and fatigue), and satisfaction (subjective feeling towards the 3 keyboards).

Results

The results show that the impact of keyboard size varies according to the dimensions of usability. A Small Keyboard leads to high efficiency but with too high a cognitive load. A large keyboard is inexpensive in terms of efficiency but is not very effective. The medium size keyboard results in good performance, is inexpensive and is preferred by individuals and therefore has the highest degree of usability.

BCI protocol device



Results obtained for P300 according to keyboard size

General discussion

Our study shows that the choice of interface (in this case the size of the virtual keyboard) has an important influence on user performance and must be considered when designing a BCI system. This type of study allows recommendations for optimal interfaces.

For further information

IMS - Équipe CIH : Jean-Marc André, Véronique Lespinet-Najib, Liliana Audin-Garcia
Institut des Télécommunications de l'université de Malaga (Espagne) : Ricardo Ron Angevin

MITOCOG: Targeting MITOchondria to improve COGnition

Scientific background

Mitochondria, cellular “power plants” and cell signaling platforms, adapt by varying their morphology between networks of long filaments or isolated dots. This “mitochondrial dynamics” results from balance between the forces of fusion and fission and maintains quality control of mitochondria. Deficiencies here are crucial for neurons and are an early event in several neurodegenerative disorders (Bertholet et al., 2016). We have shown that mitochondrial amplification in new neurons of the adult hippocampus can restore the spatial memory defects observed in a mouse model of Alzheimer’s disease (Richetin et al., 2017).

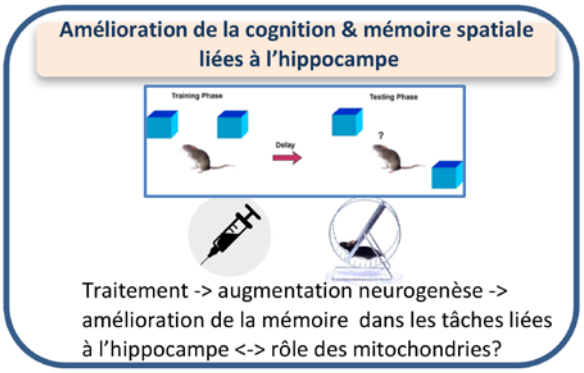
Method

Mitochondrial Dynamics can:

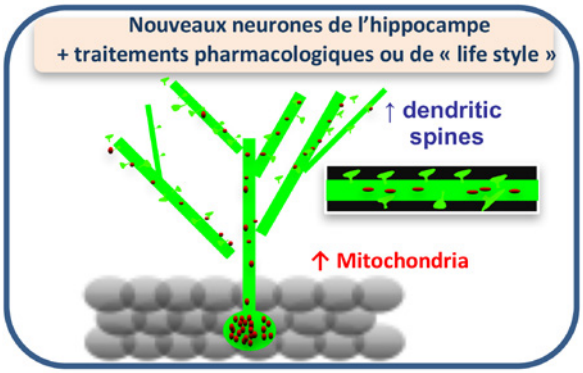
- Promote the differentiation of adult neo-neurons via an increase in mitochondrial function in a context of normal or pathological ageing.
- Aid the study the cognitive consequences of mitochondrial defects and treatments (genetic, pharmacological, life style) to restore them and determine the causal links.
- Be used in transgenic animal models, behavioral analysis; Transduction of lentivirus and retrovirus, stereotaxics; Primary culture of embryonic neurons; protein analysis, single-cell RNA seq; immunocytology and histochemistry, fluorescence microscopy, image analysis, signal processing.

Results

Our first results established the contribution of mitochondrial dynamics to dendritogenesis and spinogenesis of adult hippocampal neo-neurons in rodents (Richetin et al., 2017; Andraini et al., in preparation).



Cognitive testing and treatment of animals



Highlighting the link between mitochondrial dynamics and synaptic plasticity

General discussion

Our project is to analyze the exact role of mitochondria in the differentiation and connectivity of adult neo-neurons. This opens up therapeutic possibilities via lifestyle (exercise, diet) and treatments targeting the mitochondria in the context of neurodegenerative pathologies, and can also contribute to cognitive improvement during normal aging.

For further information

Marie-christine.miquel@univ-tlse3.fr
claire.rampon@univ-tlse3.fr
http://cognition.ups-tlse.fr
http://cbi-toulouse.fr/eng/projet-mitochondria-adult-neurogenesis-learning-and-memory-canopa

MOVE ON: Modeling to predict the evolution and treatment of dominant optic atrophia and OPA1 gene deficiency

Scientific background

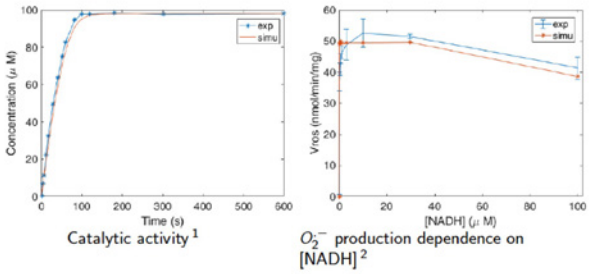
ATP is synthesised by the mitochondria from oxidation-reduction reactions catalysed by complexes in the respiratory chain.
These reactions involve intra-protein electron transfers. Production capacity of the superoxide anion, formed by the reaction of oxygen with an electron, has been identified for mitochondrial complexes I and III. Oxygen active species (OAS) are molecules derived from the superoxide anion. If they are not properly regulated by the cell's antioxidant defenses, these OAS can react with cell components and interfere with functioning: this imbalance is called oxidative stress. We use a translational approach to mathematically model OAS production and detoxification at the cellular level in many cell types.

Method

We created a deterministic model of the mitochondrial respiratory chain that can be used for different configurations and concentrations of substrates and products. We are also building a more detailed stochastic model of complex I to test interpretations from the deterministic model and to model mutations of some subunits of complex 1 and see the effects on the production of OAS.

Results

The stochastic model has shown that we can simulate the catalytic activity of complex I and the production of OAS. Deterministic models also show positive results.



1. Sherwood S. et Hirst J., 2006
2. Kussmaul L. et Hirst J., 2006

Comparison of simulations from the stochastic model for the catalytic activity of complex 1 (simu red curve) compared to the catalytic activity of complex 1 determined in vitro (exp blue curve) (left). Comparison of the stochastic model simulations of the superoxide anion production of complex 1 (simu red curve) compared to the superoxide anion production of complex 1 determined in vitro (exp blue curve) (right).

General discussion

Ultimately, the deterministic model will be compatible with patient data in the context of neurodegenerative pathologies such as type 1 dominant optic atrophy.

For further information
---
http://cbi-toulouse.fr/fr/equipe-mitochondrial-dynamics-from-neurogenesis-to-neurodegeneration

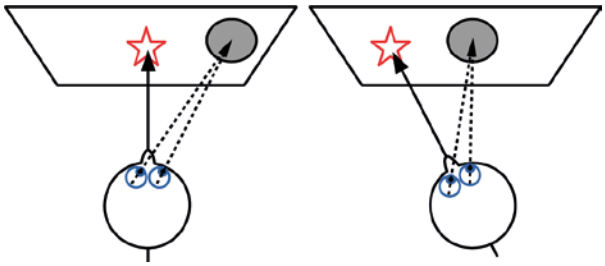
Self-augmentation of regions of interest (SAROI) in a Virtual Reality platform for the visually impaired

Scientific background

Visually impaired persons, in contrast to blind persons, have not entirely lost their visual functions. A major goal of Low Vision research is to allow patients to recover some autonomy by developing visual aids and visual rehabilitation techniques. Recent technological progress in Virtual and Augmented Reality (VR/AR) has opened rich possibilities. It is crucial, when conceiving these novel systems, to ascertain that patients will effectively use them, which implies use with ease, pleasure and without any external help. With this goal in mind, we have developed innovative human-machine interfaces and assessed their usability with low vision patients.

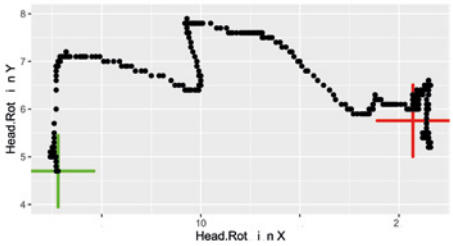
Method

In a Virtual Reality headset we placed a system allowing low vision patients to point at targets displayed at different locations in a virtual environment. Pointing was achieved with an online head-contingent pointer displayed in the virtual environment (i.e. the pointer moved with the head). In the figure below, the pointer is represented by a star for two head directions. The grey disk represents a bilateral macular scotoma (blind zone in the visual field). As soon as the pointer was aligned with the target, the latter started to blink (visual augmentation) and continued to blink until pointing had been maintained for a certain amount of time.

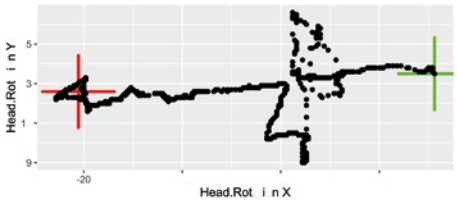


Results

49 patients with bilateral damage in the central visual field performed one experimental session of about one hour. All patients managed without difficulty to use the pointing system although their reaction times were larger than those of control subjects.



Example of head trajectory when pointing to the right



Example of head trajectory when pointing to the left

General discussion

The usability of this pointing system is good, which encourages us to pursue the development of visual aids and rehabilitation techniques in autonomous virtual reality headsets and, in the longer term, in augmented reality systems. The use of “smart” pointers will allow low vision patients either to select menu items or to trigger visual augmentations of regions of interest (e.g. faces or objects) in a scene.

For further information

Calabrèse A, Denis-Noël A, Benzi-tobar M, Wu H-Y, Matonti F, Kornprobst P, et al. Can patients with central field loss perform head pointing in a virtual reality environment ? Dublin - Vision 2020 - Conference by the International Society for Low Vision Research and Rehabilitation; 2020. Available: https://vision2020dublin.com/

Hibou, an interactive electronic book to improve reading comprehension

Scientific background

Hibou is an electronic book of interactive reading and games to help children to read more fluently.
For children who are weak readers or dyslexic, reading fluency is a major problem: their reading is slow, hesitant, and laborious. The aim is to train this skill which is necessary for successful schooling in order to achieve accurate, fairly fast, effortless reading that focuses attention on comprehension. This will encourage further exposure to written works, which is a progression factor for the reader's entry into the virtuous circle of "self-learning".

Method

Hibou is an electronic book for interactive reading and games developed for iPad:

- Children are involved in reading activities in the form of games.
- Adaptations are available for children with dyslexia or weak reading skills.
- Parents can monitor their child(ren)'s results at a glance.
- Teachers have detailed information on their students' performance, which helps to identify difficulties.
- It is associated with a CNRS and Education Nationale research protocol to advance the study of learning to read.
- It includes a choice of reading level, an option for simplifying texts and l e t t e r s p a c i n g, and a sentence-by-sentence presentation of texts to effectively help pupils.

Results

Hibou was tested by 26 teachers in schools in the Var district of France. A 3-year cohort follow-up, from CE1 to CM1 (grades 2 to 4), showed that simplifying texts helps weak readers to better understand and to increase their reading speed. Hibou has been used by more than 600 pupils, and the book is now accessible to as many parents, teachers and speech therapists as possible who wish to train and assess children's reading fluency.

Launch pages for readings and games

General discussion

Access to more readable and understandable texts allows the reader to experience a sense of success and pleasure in reading. We want to better understand the cognitive mechanisms involved in reading to better train this skill that is so necessary for successful schooling.

For further information

---

https://lpc.univ-amu.fr/fr/hibou-livre-interactif
https://books.apple.com/us/book/hibou/id1515724545?ls=1
Contact : ludivine.javourey@univ-amu.fr, stephane.dufau@univ-amu.fr, johannes.ziegler@univ-amu.fr

ParkInSon, Sonifying human movement to optimize control and (re)learning

LABORATOIRE DE NEUROSCIENCES COGNITIVES

Scientific background

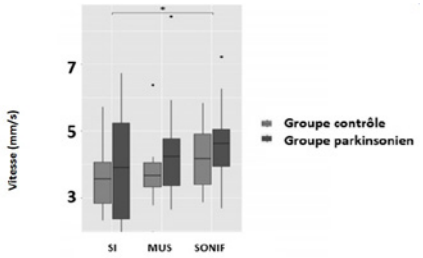
Theories from the field of motor control and learning have focused, since most movements we make our silent, on the dominant role of vision and proprioception. In the few situations where our movements produce sounds, such as in music for example, recent work in neuroscience has revealed a very close link between sound and movement, leading to a reconsideration of the potential of the auditory system to optimize movement control and motor rehabilitation.

Method

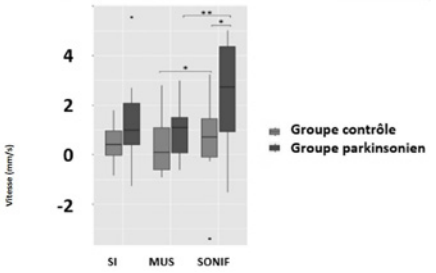
The principle of sonification of human movement, a technique of augmented audio reality, consists of transforming in real time certain variables of human movement into sound in order to enrich perception. In 2019, a sonification strategy based on music was tested with Parkinson's patients performing writing tasks. The musical sonification method consists of modifying music in real time according to the writing movement, so that the music becomes distorted when the movement is slow and jerky. This sonification strategy gives auditory feedback on movement (when the music changes) and external cues in the tempo of the music that guide the gesture (when the music does not change).

Results

1. Training with musical sonification is more effective than training with music alone in enabling Parkinson's patients to better control their writing movement.
2. The positive effect of musical sonification persists even after training, during post-tests carried out in silence.



Speed of movement during training for both groups of participants. SI: in silence; MUS: in music; SOUND: with musical soundtrack



Speed of movement during training for both groups of participants. SI: in silence; MUS: in music; SOUND: with musical soundtrack

General discussion

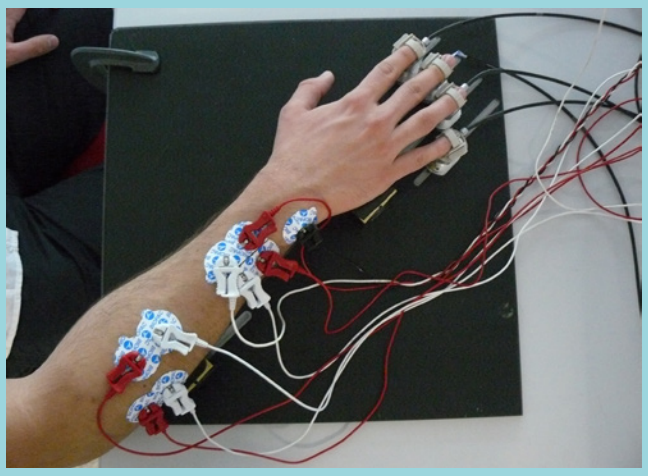
This augmented audio reality technique of using music that changes according to a person's movements seems very promising to help people with Parkinson's disease to better control their movement. In this study, only a few minutes of training were offered to the participants. We are now testing a protocol based on two weeks of rehabilitation, with Functional Magnetic Resonance Imaging before and after rehabilitation, in order to better understand these audio effects at the behavioral and cerebral levels.

For further information

Véron-Delor L., Pinto S., Eusebio A., Azulay J.-P., Witjas T., Velay J.-L., et Danna, J. (2019). *Musical Sonification improves motor control in Parkinson's disease: a proof of concept with handwriting*. Annals of the New York Academy of Sciences. doi : 10.1111/nyas.14252

Contact : jeremy.danna@univ-amu.fr
lauriane.véron-delor@univ-amu.fr

Cognitive behavioral assessments



Cognitive behavioral assessments constitute the methodological basis of cognitive sciences enabling the observation, study, understanding, characterization and, where appropriate, simulation of the mechanisms underlying the mental functioning of humans in interaction with their environment. Cognitive behavioral assessments are based on a body of knowledge, experimental methods, measurements (quantitative and qualitative) and instruments from a variety of disciplines: psychology, biology, neurosciences, medicine, mathematics, computer science, signal processing, linguistics, communication sciences, educational sciences, cognitive anthropology, philosophy, etc.

Measurement methodologies include subjective, behavioral (e.g. performance measures, non-verbal and verbal measures, etc.), psychophysical, eye tracking, as well as peripheral physiology (ECG, electrodermal activity, EMG, EOG, ...) and brain imaging (EEG, NIRS, fMRI, MEG, electrophysiology, ...) measurements. In addition to these measurement tools, other signal processing, modeling and advanced statistical methodologies (classifications, machine learning, etc.) are also used.

Aurélie Campagne (LPNC) et Nathalie Guyader (GIPSA Lab) - Coordinatrices scientifiques

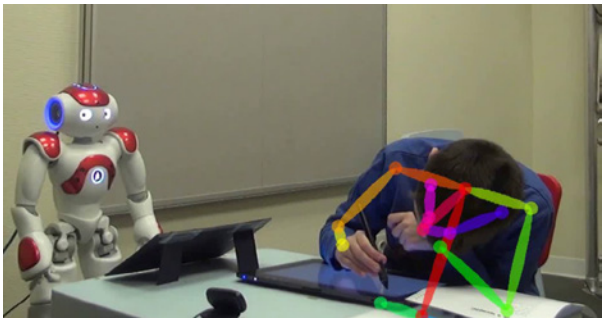
A Co-Writer robot prototype

Scientific background

About 6% of children between 5 and 11 years old suffer from dysgraphia: research underlines the importance of early detection and remediation. Therapeutic management of dysgraphia consists of long series of training sessions to help the child improve his or her fine motor control skills. These sessions can be tiring and emotionally difficult for children who often lack confidence and motivation to practice their writing skills.

Method

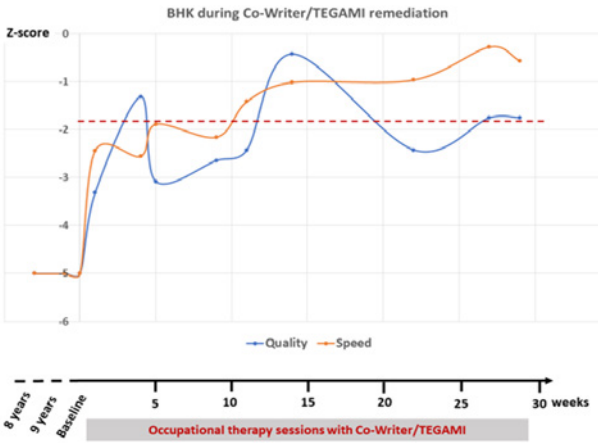
With the iReCHeCk project, in collaboration with the APHP, Sorbonne University and EPFL Lausanne, we are extending the observable measurements used by therapists through an automatic low-level characterization of writing and body posture, able to capture important non-observable micro-movements in the handwriting process. At the same time, we offer engaging training activities with a robot. The proposed system will measure the child's learning state, giving therapists the opportunity to assess the child's progress and adapt the robot's attitude and the learning task in accordance with the student's needs.
A prototype Co-Writer robot has been developed and tested in a case study.
Thanks to bilateral funding from the French-Swiss ANR-FNSF, several new activities will be designed and tested on a larger scale by including two populations of children: i) typically developing and learning to write at school with ii) impaired cognitive development and who present writing difficulties possibly accompanied by other deficits (attention, autism...).



An R. training session with the Co-Writer robot prototype

Results

The Co-Writer robot prototype was tested with R., a 10-year-old boy affected by cognitive neurodevelopmental disorders who, despite 2 years of specific accompaniment with professionals, strongly limited his participation in classroom activities. After 20 consecutive weekly sessions using the prototype, R regained his motivation: his avoidance behaviors disappeared; the quality of his writing as well as his posture significantly improved. The skills acquired also transferred outside the sessions, in speech therapy and in the classroom.



R.'s progress in terms of quality and speed of writing

General discussion

This first case study shows the feasibility and acceptability of the proposed approach. Larger-scale controlled clinical studies, as part of the ANR-FNS iReCheck project, will be able to confirm the benefits of this system in the study and remediation of dysgraphia.

For further information

Dr. Thomas Gargot
thomas.gargot@etud.univ-paris8.fr
Dr. Salvatore Anzalone sanzalone@univ-paris8.fr
Pr. Dominique Archambault
dominique.archambault@univ-paris8.fr
Pr. David Cohen david.cohen@aphp.fr

TAMED CLOUD, Sensitive Interactions with a Data Cloud

Tamed-Cloud - Subject in immersive virtual reality

Presentation at the BnF open house

Scientific background

The Tamed-Cloud project seeks to construct a sensitive, affective, aesthetic relationship with large digital datasets by presenting them in the form of virtual, living, malleable clouds. The aim is to recreate sensory, visual and tactile proximity with dematerialized data. This immersive virtual reality experience reactivates cognitive capacities, inseparable from emotion and the body in action, in complex activities of intuitive analysis or creative research.

Method

This project brings together a team of experimental designers, cognitive and computer scientists to design and produce a prototype of an immersive virtual reality experience, facilitating interaction with a mass of information through gesture and speech. The user, in the role of a researcher, curator, or collector, can select data in the cloud, consult them and organize them spatially; s/he can also enter into conversation with the cloud thanks to a speech recognition application. The cloud's behavior promotes data matching and generates possible associations, thus meeting the objectives of information access and discovery within large datasets.

Results

A proof of concept was carried out thanks to the joint support of IBM and the Carnot Cognition Institute. The production of a first functional prototype with a view to its application to business cases is under way (early financing of PSL Valorization).

General discussion

The first results have demonstrated that different actors (academic laboratories, museums, libraries, large industrial groups) are interested in the concept and several projects are being contracted. From a research point of view, this project requires a cognitive evaluation study.

For further information

Francois.Garnier@ensad.fr
EnsabLab-ENSAD/PSL Université
http://spatialmedia.ensadlab.fr/tamed-cloud/

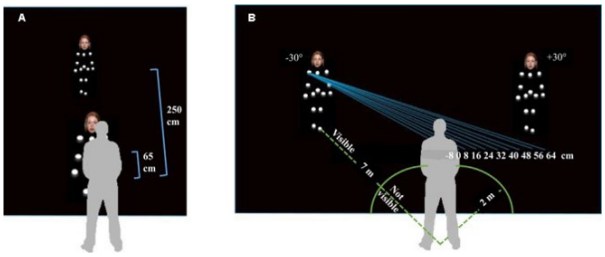
Effect of a virtual agent's facial expressions on social interactions with a human being

Scientific background

Both the peri-personal action space and the interpersonal social space are influenced by the emotional power of the facial expressions of an approaching virtual agent. The objective here was to determine whether the interpersonal comfort distance depends on the physiological response triggered by the facial expression of a virtual agent approaching the peri-personal action space.

Method

The experiment consisted of 2 tasks presenting 3D displays of virtual agents in motion represented using an animated point-light display (PLD) and with a neutral, happy or angry facial expression. In the first task, participants had to judge whether they could reach a static PLD located at different distances while their electrodermal activity (EDA) was recorded. In the second task, participants had to judge whether the distance at which the approaching PLD crossed their fronto-parallel plane was comfortable or not.



Panel A: task 1: the virtual agent is static
. Panel B: task 2: the virtual agent is on the move

Results

When the virtual agent expressed anger and was located at a reachable distance, participants showed an increased EDA and a greater distance of interpersonal comfort. The interpersonal comfort distance could be predicted from the physiological response of the participant.

General discussion

Both the peri-personal action space and the interpersonal social space are influenced by the emotional significance of social stimuli. Thus, they likely rely on common mechanisms in relation to the motorized action system. In addition, the interpersonal comfort distance can be predicted from the physiological response triggered by the emotional state of the participant.

For further information

Cartaud A., Ruggiero G., Ott L., Iachini T., and Coello Y. (2018). *Physiological response to facial expressions in peripersonal space determines interpersonal distance in a social interaction context*. Frontiers in psychology, 9.

Are women perceived as worse magicians than men? Gender bias in the evaluation of magic tricks

Scientific background

Over the past fifty years or so, a great deal of research has investigated the influence of gender stereotypes on the creation of biases (Goldberg, 1968; Swim, Borgida, Maruyama and Myers, 1989). In line with this research, we have the influence of gender bias in an artistic field that is represented by a minority of women: sleight of hand or magician. This study reveals the existence of a judgmental bias against women that can lead to an underestimation of their performance compared to that of men.

Method

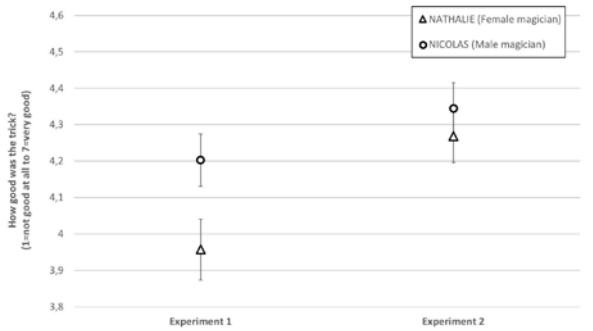
Experiment 1
64 students (33 women, average age 23; SD = 4.15) from the University of Fribourg were exposed to 14 magic tricks presented on video. The illusionist was gloved, dressed in a loose T-shirt and filmed at the level of lower bust so that gender could not be inferred. For half of the participants, the magician was presented as a man (NICOLAS), for the other half as a woman (NATHALIE). After each round, participants were asked the following three questions:

1. ”How good was the trick (1 = not good at all, 7 = very good)?”
2. “How impressive was it (1 = not impressive at all, 7 = very impressive)?”
3. “Did you guess what the secret of the trick is (1 = not at all, 7 = absolutely)?”

Experiment 2
173 students (107 women, average age = 21.4; SD = 3.91) from the University of Fribourg participated in the same procedure as in Experiment 1. The only difference was the presence of a fourth question: “Even if you have not found the secret of the round, try to explain how the round works”.

Results

Experiment 1 shows that the magic trick the participants believe is performed by a man (NICOLAS) is on average rated better than the one they believe is performed by a woman (NATHALIE).
Experiment 2 shows that this gender difference disappears when the participants have to give an explanation for the tricks they evaluate.



Comparison between Experiment 1 and Experiment 2 for the effect of the illusionist’s gender (Nathalie or Nicolas)

General discussion

These two experiments show that, in the field of sleight of hand, gender stereotypes can generate judgement bias against women. This gender stereotype could be reduced by activating a more controlled analysis (system 2) against biased judgement.

For further information

Gygax P., Thomas C., Didierjean A. and Kuhn G. (2019). *Are Women Perceived as Worse Magicians Than Men ? Gender Bias When Evaluating Magic Tricks*. Social Psychological Bulletin, 4, 1-19.

Creativity

Scientific background

Creativity refers to the ability to generate productions (ideas, realizations) that are both original and adapted to their context. Creative potential is measured by simulation tests such as the EPoC (Evaluation of Creative Potential) battery.

Method

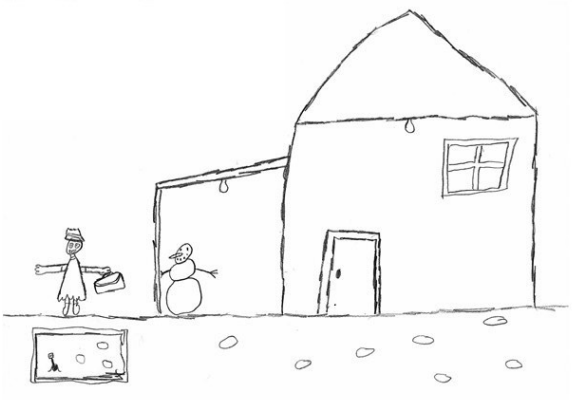
An OECD study in 11 countries examined the educability of creativity in children. The study involved a pre-test, followed by teaching that promotes creativity, and then a post-test. In each country, there were both children in “intervention” and “control” schools. The EPoC measures assessed divergent and convergent-integrative creative thinking in the pre/post tests. Many additional measures were also associated with this international study.

Results

There was, in general, a positive impact of the interventions promoting creativity. These effects were observed in a diversity of cultural contexts. In terms of psychometrics, the EPoC battery showed sensitivity, fidelity and factorial validity.

General discussion

In the context of 21st century competencies (critical thinking, creativity, collaboration, communication), research and interventions will have to be based on measurements. This work illustrates the implementation of this type of measure for creativity.



Example of a “less” creative production

Example of a “more” creative production

For further information

Lubart T., Besançon M. et Barbot B. (2019). *La créativité, ressource potentielle de l’enfant et l’adolescent, à évaluer, révéler et développer*. Neuropsychiatrie de l’Enfance et de l’Adolescence, 67(3), 121-129. Stéphan V. L., Carlos G. S., Mathias B., Meritxell F. B., Gwénaël J., Joaquin,U. and Quentin V. (2019). *Educational Research and Innovation Fostering Students’ Creativity and Critical Thinking What it Means in School: What it Means in School*. OECD Publishing.

VICTEAMS, Virtual Characters for team Training: Emotional, Adaptive, Motivated and Social

Scientific background

The VICTEAMS project, funded by the ANR, has developed virtual environments populated by autonomous virtual characters (AVC), that support the training of medical team leaders to deal with crisis situations in complex socio-technical environments. The project has mobilized a multidisciplinary team of researchers in computer science, psychology, ergonomics and medical doctors.

Method

The method relies on field and laboratory studies to 1) understand the work activities of medical leaders and trainers, 2) identify behavioral markers of non-technical skills, 3) identify subordinate non-verbal behaviors related to these skills.
These elements were used as input data to build the computer models related to the AVC as well as the scenario engine for the training situations in the virtual environment. In addition, evaluations were carried out on intermediate versions of the virtual environment from a triple point of view (computer science, psychology and ergonomics) in order to support the design of the final demonstrator.

Results

We have developed a virtual military rescue center: the participant leads a team of virtual rescuers to whom s/he gives instructions via an interactive interface in a virtual reality helmet. The virtual characters follow non-scripted behavior that allows them to obey the participant's orders, take initiatives and react via their non-verbal behavior. 230 descriptors of medical leaders' performance, including 30 descriptors related to non-technical skills, were constructed and used for the design of the scenarios as well as the evaluation of trainees. Results highlight the need to train medical leaders to consider the behavior of their subordinates in order to improve non-technical skills related to leadership and communication among leaders.

General discussion

We aim to improve the virtual character environmental perception model and to increase the realism of the characters' behavior in the simulation.
Explanatory elements will be based not only on instructions received, actions of other rescuers and personality profile, but also on the elements perceived or not perceived in the simulation. The project shows the difficulty of distinguishing between technical and non- technical skills; further studies focused on the articulation of technical and non-technical dimensions in the performance of medical leaders are required. Finally, a longer-term evaluation of this type of virtual training environment could support use in professional training situations.

For further information
---
vincent.boccara@limsi.fr ; virginie.demulier@limsi.fr ; nicolas.sabouret@limsi.fr

Improving novel word generalization in children: The role of comparison

Scientific background

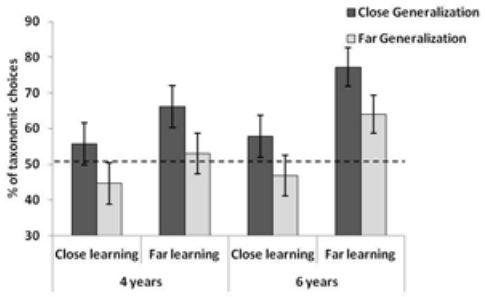
In most lexical learning situations, a single example (a drawing, for example) is introduced to illustrate the object or category for which the name has to be learned. Recent work shows that so-called stimuli comparison situations (two or more training stimuli) are more effective for lexical generalization than a single example.

Method

We contrasted “comparison conditions”, in which two familiar stimuli are introduced simultaneously with the same name (an apple and an orange called the same non-word “daxi”) with “a single condition” in which a single stimulus is introduced with its name. We manipulated the semantic distance between the learning items (close or far), as well as the distance between the learning items and the transfer items.

1. Lexical learning phase of non-words of a fictitious language for children from 4 to 6 years old: Stimuli are images of familiar objects (e.g., an apple and / or an orange).
2. Transfer phase: a perceptually similar but conceptually unrelated stimulus (eg, a Christmas ball) and a taxonomically related but perceptually dissimilar stimulus (e.g., a banana) are presented and the child has to choose the one that would also be called a “daxi”.

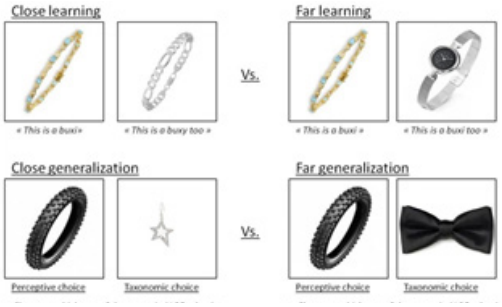
In the no comparison situation, only one of the two learning stimuli is displayed. The transfer phase is identical.



Generalization at 4 and 6 years of age as a function of conceptual distance

Results

Comparison situations gave more correct taxonomic generalizations than single no comparison situations (more perceptual responses). Far learning situations (far induction) gave better results than close learning and near generalization was better than far generalization.



Learning (above) and transfer (below) stimuli, as a function of semantic distance

General discussion

Results show that generalization accuracy depends on the semantic distance between learning and transfer items. They also show that situations without comparison are less effective than situations with comparison. In a later experiment, eye movements were recorded and revealed that participants first explore the learning items then the transfer items, which they compare one by one to the learning items. Those who did not follow this exploration pattern had poor transfer results. These results suggest that design parameters, which are neglected in most books and learning situations; are important for lexical-conceptual generalization. Instead, most novel word learning is a single presentation and learning items are chosen without any conceptual justification.

For further information
---
jean-pierre.thibaut@u-bourgogne.fr

Eye movements and visual analysis

Scientific background

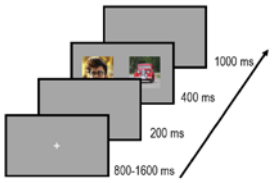
Human eyes are in constant motion, and eye movements are involved in almost all human activities. Thanks to eye-tracking techniques, the study of eye movements provides an extremely rich source of information for understanding visual recognition mechanisms (e.g. for determining the areas of interest in a visual scene), and a useful tool for evaluating many cognitive processes.

Method

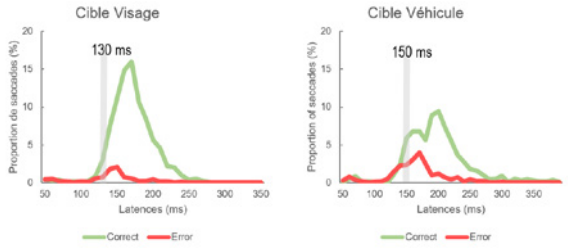
In collaboration with LPNC researchers (A. Campagne, A. Chauvin, L. Kauffmann, M. Mermillod and C. Peyrin) we have developed a saccadic choice task in which the eyes are used as a "response means ". In this paradigm initially proposed by colleagues in Toulouse (S. Thorpe in Cerco), 2 images are simultaneously presented to the right and left of a central fixation point, and the participant must direct their gaze as quickly as possible towards the target image, e.g. the image containing a face, or a face expressing fear, or a scene associated to a given emotion. Saccades can be triggered quickly (less than 150 ms) while a manual response, e.g., pointing to the target image, requires a longer time (around 300 ms).

Results

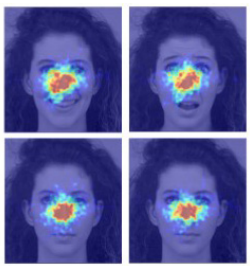
The saccadic choice paradigm associated with eye movements, focused on recording the first saccade after the appearance of the 2 images, has a number of research applications. It allows a study of the capacity to generate extremely rapid voluntary saccades towards a target stimulus, to explore the role of visual information presented in the periphery of the visual scene, to address the recognition of complex visual stimuli (i.e. faces), as well as the capacity for on-line calibration of saccade trajectories. It appears that saccades towards a face image are extremely fast with latencies between 100 and 130 ms. An important new finding is that saccade amplitude is larger for correct than for incorrect saccades, suggesting online correction of the saccade trajectory towards distractors. We have also used this paradigm to study the detection speed of emotional faces and more generally of emotional scenes.



Saccadic choice paradigm. The participant must direct their gaze as quickly as possible towards the image containing a pre-defined target (here, a face).



Participant saccades appear faster (shorter saccade latency) towards the face than towards the vehicle, and within 130 ms the correct saccade rate is larger than the error saccade rate (this minimum latency is extremely short).



Saccadic choice in an emotional face detection task. When participants direct their gaze towards the emotional face they are faster and they direct their saccades towards the lower part of the face.

General discussion

The saccadic choice paradigm exploiting saccades as a behavioral response is easy to implement and provides an extremely reliable tool for studying processing speed and attractiveness of visual information.

For further information
---
nathalie.guyader@gipsa-lab.fr

Characterization and monitoring of human stress - From the controlled situation to the ambulatory one

Laboratoire de Psychologie et NeuroCognition

Scientific background

Peripheral physiological activities are biomarkers for monitoring psychological stress in natural situations. However, despite the growing know-how in affective computing, applications from results obtained with stress detection algorithms based on physiological measurements remain unsatisfactory. This research, carried out in collaboration between 3 laboratories (LPNC, Leti-CEA, GIPSA-lab), aims to identify a widely applicable and reliable index based on physiological characteristics that are sensitive and specific to psychological stress. It must consider the various stressful situations of everyday life and the specificities of ambulatory measures for algorithmic development of relatively robust models regardless of the context in which the stress is encountered.

Method

Given that real-life measurements do not provide reliable measures of psychological stress, a theoretical framework based on a multitasking experiments dissociated the physiological characteristics most sensitive to stress ("Pressure" and "Constraint") from those related to confounding contextual factors (cognitive activity required by the task - Activity - and variations in individual basal physiological state - Background). We used tasks involving different stressors: social, temporal, cognitive, physical, and control tasks and acquired multimodal cardiac, respiratory and electrodermal recordings.

Results

Most of the physiological characteristics considered in stress detection do not allow a multi-subject distinction of the physiological state of stress from states related to cognitive activity required by the same stress-free task. However, our work highlighted some specific physiological characteristics of stress such as the mean and standard deviation of the heart rate, the square of the mean root of successive differences in heart rate, and the measurement of auto- correlation of the respiratory signal.
We also used this paradigm to study the speed of detection of emotional faces and more generally of emotional scenes.

	Score	Pressure	Constraint	Task	Activity	Background
Standard deviation of the heart rate	0.75	0.78*	0.72*	0.88*	0.32*	-0.46*
Mean of the heart rate	0.72	0.72*	0.71*	0.85*	0.66*	0.13
Autocorrelation of the respiration signal	0.71	0.65*	0.76*	0.81*	0.42*	0.21
Root mean square of the successive differences in heart rate	0.51	0.51*	0.51*	0.74*	0.30	-0.18
Standard deviation of the respiration signal	0.42	0.48*	0.36	0.81*	0.80*	-0.21
Root means square of the 1st derivative of the slow component in skin conductance signal	0.40	0.46*	0.34*	0.77*	0.46*	-0.35*

Stress-Sensitive Features and their Effect Size for Each Estimator (*p<.05)

General discussion

Although these results are encouraging, the identification of new physiological characteristics as context-independent biomarkers of stress remains necessary for a reliable stress estimation model. This is particularly true in stressful everyday situations for individuals in the general population. This is the subject of a second ongoing experimental protocol.

For further information

Vila et al. (2019). *Biomedical physics & Engineering Express*, 5(5), 055007

aurelie.campagne@univ-grenoble-alpes.fr

Analysis of mental representation MERIA, in pilots

Scientific background

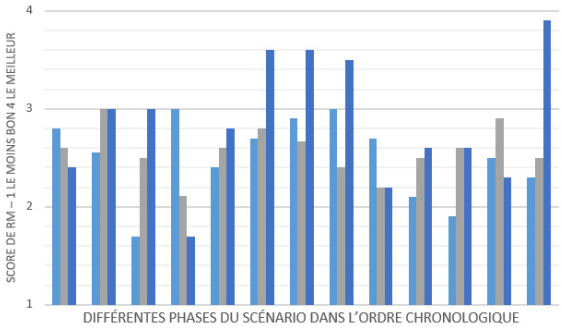
A continuous evolution of the Human-System Interfaces (HSI) is necessary to keep the operators in an optimal situation. This is especially true when their task is mainly decision-making. Determining the mental representations of operators is a key element in decision making. By looking at performance from the perspective of optimal decision-making, we have created a specific methodology focused on the mental representation (MR) of operators called MERIA (Mental Representation Impact Analysis)

Method

Several studies have characterized the mental models utilized by Airbus A320 pilots during decision-making but without a method for analyzing mental representation and its evolution over time. To this end, we have designed a new methodology and tool for data collection and analysis which considers the need for alignment between mental models of operators and data of the displayed system. This MERIA tool aims to compare the prescribed and actual MRs of the operators by using a specific scenario which allows following the evolution of the operator's MR. The operator is filmed and observed live by two experts, who then subject him/ her to a recorded self-confrontation interview. The results of this interview are analyzed by each expert such that the evolution of a gap between prescribed and achieved MR during the scenario can be determined. This method makes it possible to compare different interfaces and also allows study of the evolution of an operator's MR when using a new system, for example during training.

Results

The MERIA approach makes it possible to interrogate the MR of operators, to identify discrepancies between observed and prescribed MR, and also discrepancies between the mental image expected by the operator and that produced by the HSI. In this way, it is possible to identify gaps in MR and to identify the origins of these gaps (often in terms of HSI). The method is particularly well suited to the needs of rapid prototyping of new interfaces.



Comparative analysis of the MR (from 1 to 4) of pilots in three different cockpits (Light Blue, Grey, Dark Blue) in relation to different phases of a scenario (x-axis). Average MR per phase, 10 pilots per cockpit type.

General discussion

The MERIA method offers a complete vision of the different points of view of the activity of an operator in action in a complex dynamic environment. This tool is intended for experts in the field, both for reading of analyses and for their application. It is synthetic and uses a very technical vocabulary. Popularizing its terms would make it more accessible to non-experts, but this would complicate modeling and reduce its synthetic nature. The cost of applying this method is not negligible, even for an expert. The real complexity of the method comes from the time-consuming aspect of observations, interviews, and their processing, especially since the analysis requires the involvement of at least two experts.

For further information

Letouzé, T., Créno, L., Diaz-Pineda, J., Dormoy, C. A., Hourlier, S., & André, J. M. (2020). Mental Representation Impact Analysis (MERIA), a method for analyzing mental representations for the design of HMI. A case study in aeronautics. *Le travail humain*, *83*(1), 61-89.Work carried out as part of the European Union's Future Sky Safety - Horizon 2020 programme under grant agreement no. 640597.

Benefits of motor action on timing in childhood

LABORATOIRE DE NEUROSCIENCES COGNITIVES

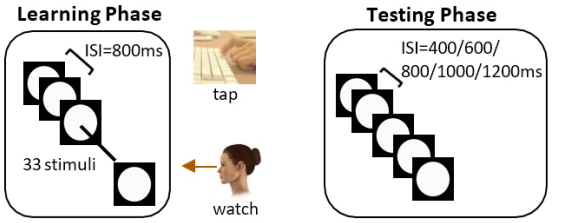
Scientific background

There is a strong functional and neural overlap between motor action and timing:

- Motor brain structures (e.g., basal ganglia or supplementary motor area) are recruited during timing, even in the absence of movement
- Adult performance on perceptual duration discrimination tasks improves if test durations are learned via rhythmic movement (tapping)
- The temporal benefits of motor action might be particularly useful for young children whose estimates of time are very variable

Method

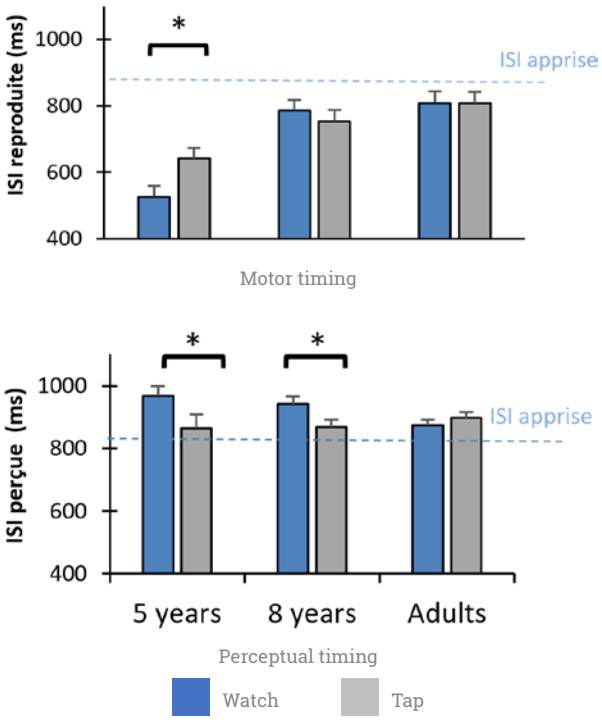
Adults and children (5 or 8 years old) learned the duration of a rhythmic interval with or without concurrent motor action.



During learning, participants either tapped in time to a visual rhythm ("tap") or simply observed the rhythm on the screen ("watch").
We then measured their timing performance using tasks of either motor timing (reproduce rhythm) or perceptual timing (compare to learned rhythm).

Results

- Synchronized tapping during learning helped children to construct a more accurate representation of time
- The beneficial effects of motor action on timing performance were significantly greater in children than in adults
- Timing accuracy correlated with individual differences in motor and memory capacity in the "watch", but not in the "tap", condition



General discussion

- Motor action helps children to construct an independent and flexible representation of time, independent of cognitive capacity.
- Motor action helps relieve the cognitive burden of learning about time.

For further information

This work is the result of a collaboration between Aix-Marseille Universite & Université Clermont Auvergne.

Contact : jennifer.coull@univ-amu.fr
sylvie.droit-volet@uca.fr et florie.monier@uca.fr

Monier F, Droit-Volet S, Coull JT (2019) *The beneficial effect of synchronized action on motor and perceptual timing in children*. Dev Sci: e12821

Collective Cognition

To study natural and artificial interactions in different contexts (emotional, cultural, etc.) in order to understand the underlying processes (cognition, communication, etc.), social, belief and emotional regulations in individual and social contexts, stereotypes, effect of the social context on cognition and human-human interactions/animal/virtual agents/robots).

Valérian Chambon (IJN) - Coordinateur scientifique

The Sense of Community in Joint Action

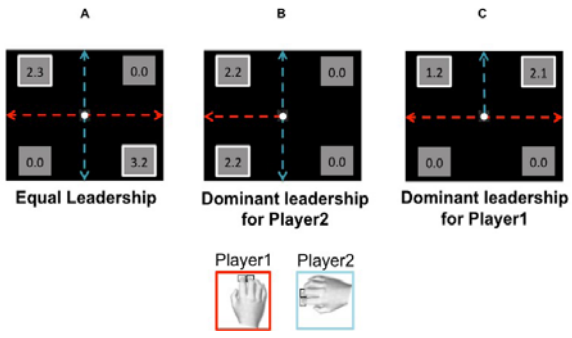
Institut | Nicod
CNRS-EHESS-ENS

Scientific background

This research project, funded by an ANR PRC, focuses on the cognitive foundations of collective action. It aims to characterize the feeling of "acting together", and to examine the ways in which high-level (strategic) and low-level (sensorimotor) coordination processes interact to give rise to a sense of community in collective action.

Method

We hypothesized that the sense of community in joint action requires at least two "abilities": the ability to coordinate one's movements with others (motor coordination), and the ability to coordinate one's interests with the interests of one's partner (strategic coordination, or cooperation). A series of behavioral protocols inspired by work on action control in cognitive neuroscience and the formalism of Game Theory in experimental economics tested this hypothesis. In these protocols, the two types of coordination (motor and strategic) were manipulated in order to precisely quantify their respective contribution to the participants' sense of "acting together".



Experimental protocol.
Each participant controls the movements of a cursor on one axis only (vertical or horizontal). The objective of the task is to reach one of the target squares. At the center of each target, are the gains that each participant can make. Strategic coordination requirements are manipulated by varying the relative gains within each target. Motor coordination requirements are manipulated by varying the importance of one axis or the other.

Results

Individual and collective sense of community are sensitive to experimental characteristics. The feeling of community in individual action correlates with performance and "pivotality" of individual agents (i.e., the extent to which the individual contributes to the joint action), while the sense of "acting together" (or sense of community) is not sensitive to the pivotality of individuals but depends on how the benefits of joint action are distributed between individuals. The feeling of community in joint action is highest when benefits are distributed according to the respective contribution of the individual ("fair" distribution).

General discussion

The overriding importance of strategic cues for the sense of community in joint action reflects the presence of a shared representation of interests among the individuals of an interaction. The emergence of this shared representation makes the experience of 'acting together' particularly sensitive to the way in which the benefits of the interaction are distributed among the partners.

For further information

Le Bars S., Devaux A., Nevidal T., Chambon V.* and Pacherie E.* (2019). *Agents' pivotality and reward fairness modulate sense of agency in cooperative joint action*. *co-senior authors. Cognition, 195, 104117.

Creating an environment of communicating objects

Scientific background

Suricats Consulting is a digital transformation agency developing activities in the field of “Phygital”. EnsadLab’s Reflective Interaction group is coupling interaction design and cognitive sciences on the behavior of objects, i.e. how the movements of robotic objects can be perceived as behaviors. Coupling with the Internet of Things (IoT), a collaboration with Olivain Porry’s Cifre thesis entitled « An artistic and esthetic method for machine communication » (Un régime artistique et esthétique des communications entre machines) has resulted.

Method

The creation of prototypes has led to the production of swarms of robots used to experiment on and illustrate modalities of collective expression and to test interaction protocols between a user and a collective of objects connected in a network.
This joint research, one phase of which was developed with the CHArt laboratory as part of a project (ICOC, supported by the Cognition Institute), focuses on behavioral design to visualize exchanges between connected objects. From a cognitive science point of view, the objective is to model interpretation of collective action, as well as new modes of communication with networked objects, taking into account the aesthetic and emotional dimension.

Results

These experiments in the ways in which a viewer accesses the collective dimension of a work make it possible to lay the foundations of a science of interpretation of collective behaviour based on an ontology of the behaviours of connected objects by listing a set of action verbs and categorising them according to classes capable of defining the segments of the behavioural organisation of objects endowed with behaviours.

This research also supports several swarm robot projects on the perceived qualities of collective movement.

A collection of objects moved by vibration and controlled by commands sent to a leader.

Installation “Enlightenment” (2020), created by Olivain Porry (EnsadLab) to experiment with a collective of light modules.

General discussion

Connected objects can be expected to increasingly interact, or even collaborate, with each other. The next step is to understand how this collaboration can be monitored, supervised, controlled and, to this end, modelled and simulated. The study of the relationship between the behavior of connected objects and the interpretation of this behavior suggests a natural control device. This starts with verbal expressions, the use of action verbs, and finishes with the ability to manage Human-Connected Objects interactions.

Augmentative and alternative communication (AAC) for children with complex communication disorders

Scientific background

Augmentative and Alternative Communication (AAC) methods using pictograms accessible via manual- or eye-pointing, together with vocalization, are essential to support the communicative and language development of children who cannot speak or gesture and whose cognitive difficulties limit language development. However, these methods are still underused. How can we facilitate access to AAC tools to support cognitive and language development?

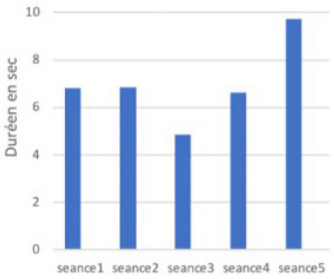
Method

The AAC underuse by children with complex communication disorders is linked to at least 3 factors: 1) the lack of free tools with a vocabulary adapted to the French culture and whose use does not require intensive training for adaptation to everyday life; 2) the lack of objective empirical analysis of the effect of the tool on a child's communication; 3) persistent inappropriate beliefs among professionals and parents, generally due to a lack of information. We have worked on these 3 types of problems with a specific focus on (a) the development of free software accessible online for the design of communication grids using the "Angular" technology and integrating knowledge from language sciences (AugCom); (b) the multimodal analysis of 5 filmed sessions between a 5-year old child and her mother exploiting a simplified communication grid with a software used by the family (Proloquo2go©); (c) the organization of a free day of conferences at the Maison de la Création et de l'Innovation de Grenoble (MACI, UGA) in February 2020.

Results

An online version of the AugCom software has been developed (http://lig-augcom.imag.fr/stable/#/keyboard, https://github.com/schwabdidier/AugCom) and will be evaluated. The analysis of mother-child interactions suggests the importance of video recordings to reveal the child's communicative behaviors and the role of the tablet and the camera in these interactions. Additionally, about 50 participants (mainly parents and care professionals) took part in the free day of conferences where they made contacts with different care institutions.

Example of a communication grid on AugCom



Duration of the child's gaze towards the tablet during the 5 sessions of interaction with their mother

General discussion

This work is laying the foundations for a multi-dimensional collaborative project between LIG and GIPSA. The challenge is to design communication grids adapted to the target population that can be implemented in AugCom and evaluated in context through usage analysis.

For further information
---
amelie.rochet-capellan@grenoble-inp.fr
didier.schwab@imag.fr
marion.dohen@grenoble-inp.fr

The ACDC model: Analysis of communication in a cooperative dyad

Scientific background

We are interested in situations of collective cognition (KX) and more particularly in dyad cooperation. The objective is to characterize communication exchanges within a dyad in order to propose a graphical representation of the temporal dynamics of these exchanges and thus to determine the social roles of the individuals. The idea is to formalize and validate an analysis model called the ACDC model.

Method

The method consists of several steps:

- Development of the ACDC analysis model integrating classical theoretical models (Bales, Searle, Vernant, etc.)
- Validation of the typology used in our model (focus group and card sorting)
- Experimentation: gathering of dyad data on a cooperative tetris task
- Application of our model to the data
- Inter-judge validation (via Kappa-Copen)
- Formalization definition of our ACDC analysis model

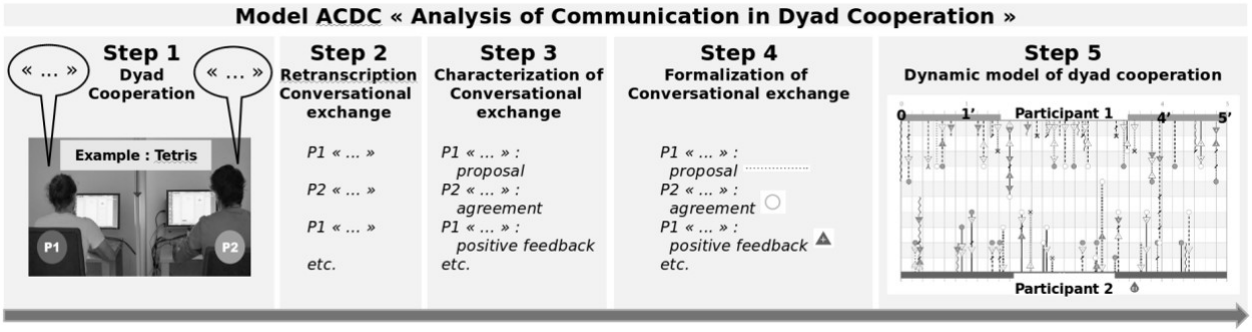
Results

Our methodological approach enabled validation of the model. This formalisation is based on 2 important points:

- Determining a typology to characterize the nature of conversational exchanges.
- Proposing a graphic representation to illustrate the exchanges and the temporal dynamics.

General discussion

Our model was applied to a situation of dyad cooperation in a controlled context. There are many other possibilities: collaborative tasks, use in more natural situations, characterization of exchanges between more than 2 people, etc. Further is the aim to automate the graphic representation steps.



For further information

Team CIH : Jean-Marc André, véronique Lespinet-Najib, Théodore Letouzé and Delphine Graeff

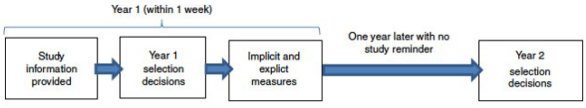
Influence of gender stereotypes in researcher promotion

Scientific background

Women remain under-represented in scientific research: Combining all disciplines at the CNRS, the average percentage of female researchers is 35% and 29% for research directors. Does gender discrimination contribute to this under-representation? The objective of this study was to examine whether implicit gender bias has an impact on decisions made at the highest level of researcher promotion: those made by the National Committee for Scientific Research (CoNRS) for access to the body of research directors.

Method

The 40 sections of the CoNRS were monitored for 2 years. In the first year, evaluators took the implicit association test, which measures stereotypes anchored in semantic memory in the form of automatic associations. A questionnaire investigated possible explanations for the under- representation of women in science and whether or not gender discrimination existed. In the second year, nothing was asked of the evaluators so that they would not feel that they were participating in a study.
The number of male and female candidates selected eligible by the CoNRS was analyzed for both years.



Adverse Impact (IA) =
Decision Parity Index which takes into account the F/W ratio among applicants

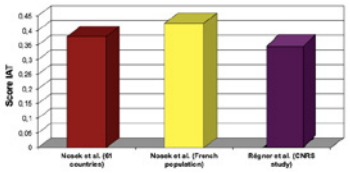
$$P_f = n_f / N_f$$

$$P_m = n_m / N_m$$

$$AI = P_f / P_m$$

Results

From particle physics to the social sciences, both male and female scientists tend to associate “science” and “male” (rather than “science” and “female”).
In the CoNRS section that denied discrimination against women (1 of 2), the stronger the implicit stereotypes of the evaluators, the less women were promoted. This influence did not exist in the sections that admitted possible discrimination.



Comparison of the IAT score obtained in this study (in purple) with that of Nosek et al (2009, PNAS) from 61 countries.

Promotion decisions (year 2) based on implicit gender bias and belief in gender discrimination, while monitoring selection decisions made in the previous year.

General discussion

This study indicates the existence of implicit gender bias among researchers in all disciplines that may be detrimental to the careers of women scientists. There is a need to provide training that 1) raises awareness of the existence of these stereotypical biases, 2) explains how these biases operate and what the consequences are, and 3) proposes strategies to better control these biases and thus reduce their impact.

For further information

Régner I., Thinus-Blanc C., Netter A., Schmader T. and Huguet, P. (2019). *Committees with implicit biases promote fewer women when they do not believe gender bias exists*. Nature Human Behaviour, 3, 1171–1179. doi: 10.1038/s41562-019-0686-3

Development of automatic interpersonal motor alignment

Scientific background

Interpersonal motor alignment refers to the adjustment our motor behavior to that of others. Studies in adults show that:

- It is often unconscious and is ubiquitous in daily social life.
- It relies on motor resonance mechanisms and is a building block for higher social cognition
- It promotes group cohesion and positive social effects.

How interpersonal motor alignment develops and changes in ontogeny, especially after infancy, is rarely discussed.

Method

We conducted a systematic review on four types of interpersonal motor alignment:

- Synchrony (including brain to brain): the temporally matched behaviors of interaction partners
- Mimicry: matching of behavior with a slight temporal delay (3 - 6 seconds)
- Automatic imitation: Stimulus-response compatibility paradigm in the motor domain, measuring imitation
- Observe action: Automatic brain motor circuit engagement during action observation

We identified empirical studies investigating these phenomena and measured behavior or brain activity during development in healthy populations.

	Synch	Mim	Im Aut	ObsAct	Total
Infants	8	9	4	11	32
Children	11	4	10	24	49
Teenagers	3	1	2	6	12

Interpersonal motor alignment is present very early

Deficit of investigation in adolescents

Motor resonance identified at brain level very early on. Modulation continues to mature throughout childhood and adolescence

Number of studies identified for Infants (<3y), Children (3-11y) and Adolescents (11-19 y); Snych = Synchrony, Mim = Mimicry, Im Aut = Automatic Imitation, ObsAct = Observe Action

Results

Instances of interpersonal motor alignment are present in all age groups. They:

- depend more strongly on social factors and context than on motor abilities
- are associated with positive social behaviors (cooperation, helping, sharing)

A lack of interpersonal motor alignment starting at birth is linked to persistent emotional and social difficulties. In adolescents, there is a gap in the literature on interpersonal motor alignment.

General discussion

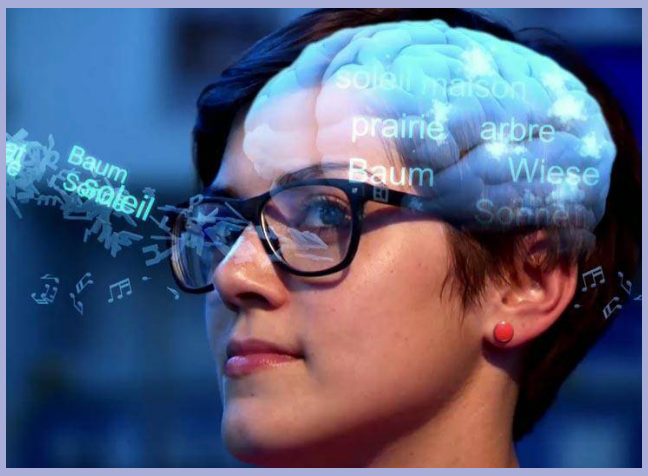
- Reliable interpersonal motor alignment throughout development may strengthen links between brain areas related to social cognition, action observation, and emotion. This could have long-lasting effects to enhance emotional resilience and prosocial behaviors.
- Adolescence, characterized by high social stressors and peer group dependency, is a key period during which interpersonalmotor alignment and its positive effects should be studied.
- Social motor alignment programs could be implemented online, but this awaits further investigation.

For further information

Birgit.rauchbauer@univ-amu.fr
marie-helene.grosbras@univ-amu.fr

Developmental trajectory of interpersonal motor alignment: positive social effects and link to social cognition. In revision for Neuroscience and Biobehavioral Reviews

Cognition and language



Considering linguistic cognitive processes in automatic language processing systems to improve human-machine interaction (speech, language and language processing, learning, multimodality, gestures, multilingualism, assisted translation, affects, language and speaker identification, conversational agents).

Richard Dufour (LIA) - Coordinateur scientifique

Detecting sleepiness through the voice

Laboratoire des Systèmes Perceptifs

Scientific background

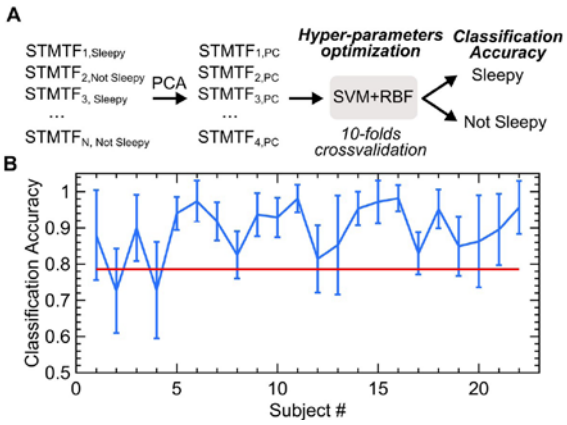
Lack of sleep drastically affects many aspects of human behavior. The early detection of sleepiness is thus a major challenge for health and security reasons. Here, we investigated the effect of sleep deprivation on the acoustic properties of human speech.

Method

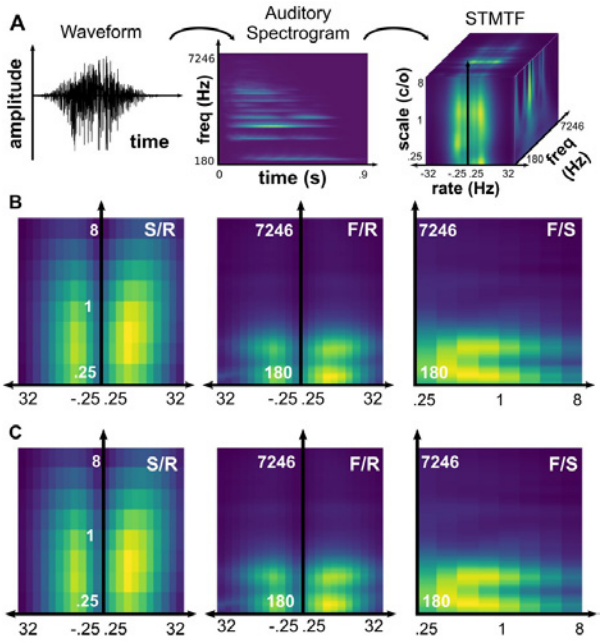
Twenty-four participants were sleep deprived for two days (two successive nights with only 3 hours of sleep). They were recorded reading a short text aloud before and after sleep deprivation. An auditory model, based on spectro-temporal modulations, was used to analyze the acoustic properties of their speech and served as a front-end feeder to machine-learning classifiers.

Results

Sleepiness could be accurately detected by individually trained classifiers. In our auditory-inspired model, we could probe the classifier to identify, and then interpret, the acoustic features impacted by sleep deprivation.



Outline of the sleepiness classifier and individual accuracy scores.



Acoustic analysis of sleep-deprived speech using an auditory model.

General discussion

The data suggests that a practical machine learning algorithm can detect sleep deprivation. Additionally, our method of classifier combined with voice production considerations could help uncover physiological impacts of sleep deprivation at the individual level.

For further information

Daniel Pressnitzer, LSP et ENS
daniel.pressnitzer@ens.fr
Damien Léger, Sorbonne Paris Cité, APHP, Hôtel Dieu; Thomas Andrillon, Monash U., Australie, Étienne Thoret, LSP & Aix Marseille U.

Do babies prefer infant-directed speech or adult-directed speech?

Scientific background

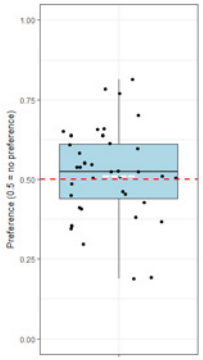
A study in 2018 brought together 68 BabyLabs from around the world to address a well-known phenomenon: that babies prefer infant-directed speech ("baby talk" or "mamanais" in French) to adult- directed speech. Infant-directed speech is characterized by a higher frequency of the voice, greater modulations and a slower rhythm. The 2018 study aimed to determine if results from different labs matched and to ask the following questions: do results change with the age of the baby (we have tested 12- to 15-month olds and other labs other ages) or with exposure to more languages (we tested mono- and bilingual babies)?

Method

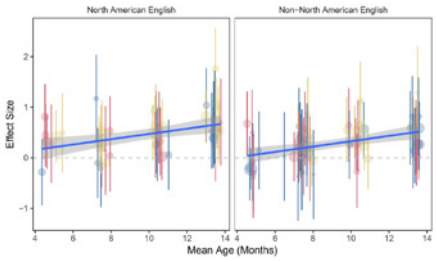
Babies were seated on a parent's knee in a small booth while geometric shapes appeared on a screen in front of them. If the baby looked at the screen, they would hear a woman speaking North American English. The woman's voice was alternately addressed to a baby or to an adult. If the baby wasn't interested and stopped looking at the screen, the voice stopped. An Eye Tracker (a camera that detects where someone is looking) allowed calculation of the time spent looking at the screen which was interpreted to mean time of interest in the voice.

Results

In this relatively small sample (41 babies), we saw the same preference for child-directed speech as previously reported. There is an average, and very consistent difference of less than one second spent listening to adult speech. Even though most babies had not been exposed to North American English, they could still discriminate, and prefer, the North American English baby talk. This preference was larger in monolingual babies, though not significant.



Each point represents the average of each baby (anonymized results). When the dot appears above the red line, the baby preferred baby talk while when the dot appears below, it is because that particular baby preferred adult- directed speech. There are more dots above the line than below, suggesting that most babies preferred to look at the screen when they heard infant-directed speech.



These graphs shows the results for native American English babies and for non-natives. The preference for baby talk increases month by month, whatever the mother tongue; we can see that the results are slightly higher for native than for non-native babies.

General discussion

In all 68 labs, infant-directed speech preference increases with age: 4-month old babies prefer baby talk and this preference strengthens at least up to the age of 15 months (oldest infants in the sample). We also found that both North American (listening to infant-directed speech in a familiar language and accent) and non-North American babies preferred infant-directed speech– but the preference was stronger in North American babies. Both the increase in preference with age and the greater preference of North American babies suggest that familiarity contributes to preference.

For further information

ManyBabies Consortium (2020). *Quantifying sources of variability in infancy research using the infant-directed speech preference.* Advances in Methods and Practices in Psychological Science, 3, 24-52.

The nature of counted objects influences problem-solving strategies

Scientific background

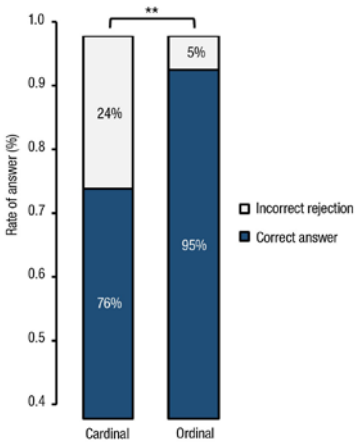
Whether counting marbles, apples, minutes or floors, addition and/or subtraction procedures used for problem solving should be the same. Our studies however suggest that this is not the case. Even expert mathematicians are influenced by the nature of the counted objects when choosing a solving procedure. These biases can prevent someone from realizing that a calculation such as 12 - 2 is the solution of a simple problem. Astonishing!

Method

We constructed problems with two types of quantities, those that adults would spontaneously see as a combination of subsets (e.g., finding the total of Paul's, Jacques's and Peter's marbles) and those that they would spontaneously see as continuous quantities along axes, such as time (e.g., finding the time needed to travel a certain number of miles). We then wrote sample problems to verify that participants would not solve the two types in the same way.
And we wrote problems that could be solved either consistent with or contrary to spontaneous views.

Results

Both expert mathematicians and university students sometimes rejected correct solutions. These errors were more frequent when the solutions did not correspond to their a priori preferred solving strategy.



Percentage of experts' correct answers and incorrect rejections depending on the type of problem.

General discussion

Results show that, contrary to what both intuition and math tell us, experts' use of arithmetic operations was influenced by the nature of objects. Since consistent and inconsistent conditions were mathematically equivalent, our non-mathematical knowledge about objects appears to contribute to our mathematical operations.

For further information

Jean-Pierre.Thibaut@u-bourgogne.fr
https://link.springer.com/article/10.3758/s13423-019-01628-3

Speech technologies: integrating knowledge about speech development and control in Artificial Intelligence (AI) techniques

Scientific background

Speech technologies make extensive use of AI tools based on large amounts of data and deep learning techniques. At Gipsa-lab and LPNC we have developed computational models simulating the cognitive and biophysical mechanisms of speech production and perception, and their ontogenetic development. This project aims to integrate the knowledge included in these models according to a Bayesian formulation in order to (1) constrain the structure and nature of deep networks latent spaces, (2) facilitate learning, and (3) enhance the versatility of speech technologies through learning transfer principles.

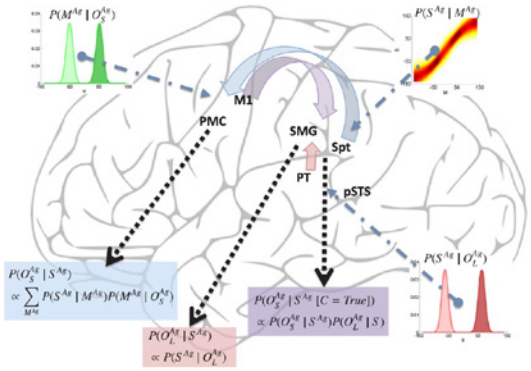
Method

Bayesian modeling indicates constraints on variables and on speech communication processes by formalizing their properties and relationships in statistical terms. We integrate these constraints in deep learning techniques to produce significant and interpretable latent variables.
Cognitive and biophysical models can generate controlled data sets in sensory-motor regions which can enrich those processed by deep learning methods. We can exploit deep learning predictions to discover dependencies between variables, interpret them with probablisistic models, and acquire new information on sensory-motor representations in the brain. The ultimate stage of our project will be production of interaction paradigms between virtual and human agents, learning to communicate by speech and adaptation to new communication contexts.

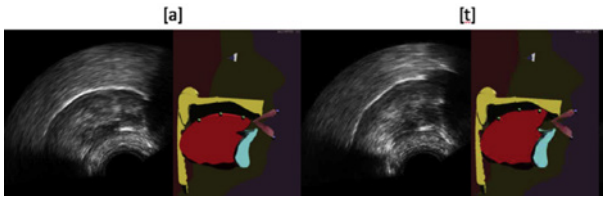
Results

Our main achievements are:

- the conception of Bayesian models of speech perception, production, and development (COSMO & Bayesian GEPPETO) (Left).
- the development of synthesizers to exploit articulatory data via machine learning (Right).



Neuroarchitecture of the Bayesian Model of Auditory-Motor Perception of Speech (COSMO)



Automatic synthesis of the /at/ sequence with a 3D model of the vocal tract from ultrasound data

General discussion

The next step for integrating the Bayesian and machine learning approaches – DeepCOSMO – will use the COSMO model with probability distributions of the variables and their relationships implemented in a deep-neural network by generative neural models of the Variational AutoEncoder type.

For further information
---
julien.diard@univ-grenoble-alpes.fr
thomas.hueber@grenoble-inp.fr
pascal.perrier@grenoble-inp.fr

FlauBERT : pre-trained contextualised neural language models for French

Scientific background

Pre-trained language models are now indispensable for achieving state-of-the-art results in many Natural Language Processing (NLP) tasks. Taking advantage of the enormous amount of unlabeled text available, they enable the extraction of continuous word representations at the sentence level. In this project with University Paris Diderot and University Paris Sciences et Lettres, the GETALP team of Laboratoire d'Informatique de Grenoble (University Grenoble Alpes, CNRS) shared FlauBERT, a set of models learned on a large and heterogeneous body of French language. Models of different sizes were trained using the new CNRS Jean Zay supercomputer. The language models performed various tasks in French (text classification, paraphrasing, natural language inference, parsing, word sense disambiguation) often outperforming other pre-training approaches, including the FLUE evaluation benchmark designed in the same project.

Method

Language approaches based on continuous representations, such as word2vec or GloVe, learn a unique vector for each word. Recently proposed models produce contextual representations that depend on the entire input sequence. Initially based on recurrent neural networks, these newer approaches (GPT and BERT) have gradually converged towards the use of a transformer. Neural network construction required more than a hundred graphics processing units (GPUs) on a computing grid, but such resources are not needed for other systems, where a simple GPU often suffices. The training data for Flaubert is 71 GB in size, gathered from 24 sub- corpora of various genres (Wikipedia, books, Common Crawl, ...). And the Flaubert models have been trained using up to 128 GPUs.

Results

- State-of-the-art pre-trained language models (May 2020) freely available for use in a wide range of tasks address text and speech in French.
- FLUE: the first evaluation benchmark for French NLP tasks. FLUE is composed of 7 tasks corresponding to different levels of analysis (syntactic and semantic).

Tâche	Classification			Paraphrase	NLI	Constituants		Dépendances		Désambiguïsation	
Section	Livres	DVD	Musique							Noms	Verbes
Mesure	Acc.	Acc.	Acc.	Acc.	Acc.	F_1	POS	UAS	LAS	F_1	F_1
État de l'art ant.	91.25[c]	89.55[c]	93.40[c]	66.2[d]	80.1/**85.2**[e]	87.4[a]		89.19[b]	85.86[b]	-	43.0[b]
Sans pré-entr.	-	-	-			83.9	97.5	88.92	85.11	50.0	-
FastText	-	-	-			83.6	97.7	86.32	82.04	49.4	34.9
mBERT	86.15[c]	86.9[c]	86.65[c]	89.3[d]	76.9[f]	87.5	98.1	89.5	85.86	56.5	44.9
CamemBERT	**93.40**	**92.70**	94.15	89.8	81.2	88.4	**98.2**	91.37	88.13	56.1	**51.1**
FlauBERT$_{BASE}$	**93.40**	92.50	**94.30**	**89.9**	81.3	**89.1**	98.1	**91.56**	**88.35**	54.9/**57.9**[g]	47.4

Final results on FLUE tasks compared to other language models for French.

General discussion

This research paves the way for significant progress on many French NLP tasks with applications for industry. Research is, for example, currently being carried out to detect named entities or psychological obstacles or motivations for the adoption of an innovation.

For further information

Github of the project : https://github.com/getalp/Flaubert - FlauBERT: Unsupervised Language Model Pre-*training for French* Hang Le, Loïc Vial, Jibril Frej, Vincent Segonne, Maximin Coavoux, Benjamin Lecouteux, Alexandre Allauzen, Benoit Crabbé, Laurent Besacier and Didier Schwab, 12th Language Resources and Evaluation Conference, 2020

FLUENCE

Development and validation of innovative digital devices for the prevention and remediation of difficulties in English and French

Scientific background

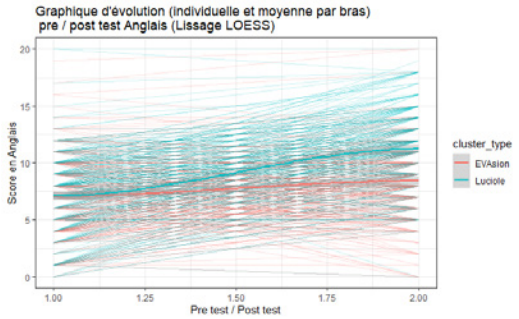
The use of digital technology in the classroom opens new perspectives for the prevention and remediation of learning difficulties. Educational games allow intensive training in relative autonomy. When including algorithms that track participant performance over time, learning can be optimized by selecting exercises that best match participant needs. However, most current educational games are not evidence-based. The goal of the FLUENCE e-FRAN project was to develop educational games for training reading in French and oral comprehension in English. Their efficiency was assessed through a large-scale study in natural context.

Method

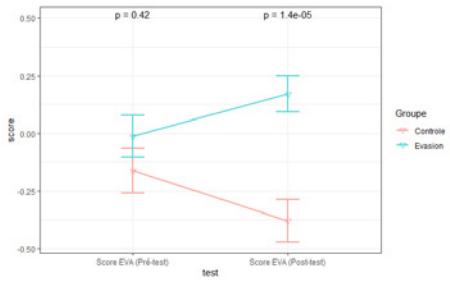
Three educational games were developed by three CNRS-UGA research teams: EVASION (LPNC, UMR 5105) for training the visual attention skills in reading acquisition, ELARGIR (GIPSA-Lab, UMR 5216) for training repeated text reading to enhance fluency, and LUCIOLE (LIDILEM) for training oral comprehension in English. The games were used by 2,000 French students in the academies of Grenoble and Mayotte for a 3-year longitudinal follow-up in primary school (1st to 3rd grade) and 2 years in middle school (6th to 7th grade). Matched experimental groups used either EVASION then LUCIOLE, EVASION-ELARGIR, LUCIOLE-ELARGIR or LUCIOLE-LUCIOLE. Assessments were performed before and after each training.

Results

LUCIOLE was shown to be successful in training oral comprehension in English in Grade 1 and Grade 2. EVASION V1 did not improve visual attention in Grade 1. A second version of the game was developed and tested in Mayotte. EVASION V2 was effective in improving visual attention and reading performance. The evaluation of ELARGIR is in progress.



Improvement of oral comprehension in English following the use of LUCIOLE



Improved visual attention span following the use of EVASION

General discussion

The educational games LUCIOLE and EVASION are successful in improving oral comprehension in English (Grade 1 and Grade 2) and reading acquisition (Grade 1), respectively. Preliminary results are encouraging for ELARGIR and will be finalized in the coming year so that effective games can be made available to teachers.

For further information
---
www.fluence.cnrs.fr
sylviane.valdois@univ-grenoble-alpes.fr

eRISK Education 2.0 and digital risks

Scientific background

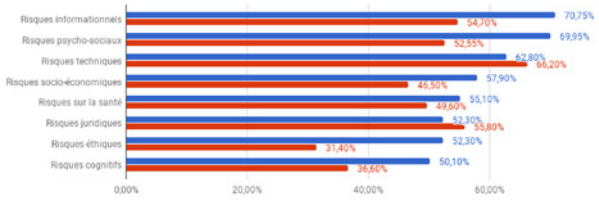
The project, funded by the MAIF Foundation, focuses on the digital training of students through the perception of digital risks by new teachers. Starting from the observation that digital literacy is approached at school from the angle of risks, the project aims to characterize digital representations and discuss digital technology in order to understand evolving teaching practices.

Method

Mixed methods: A quantitative survey was carried out in two academies (Bordeaux and Créteil, 3132 responses), followed by semi-directed interviews with new teachers in order to characterize their relationship with digital technology and their perception of risks. Then, 2 days of ideation followed by 2 classes produced representations of digital technology in 15 year old students. Finally, student digital productions made during one school year were analyzed.

Results

The digital culture of new teachers is unevenly developed, poorly informed despite their sense of expertise, and focused on the perception of psycho-social risks related to “screens”. They need training. Getting pupils to become aware of their digital practices by verbalizing them proves to be much more effective than giving them “turnkey” content.



Comparison between the risks perceived by teachers for themselves and for their pupils

Representation of their practices by the pupils: creation of a comic book in the classroom.

General discussion

The team is pursuing research on the analysis of formal and informal digital representations and practices in education and training based on the real experiences of pupils and teachers.

For further information
---
https://erisk.hypotheses.org/1
https://www.lesjeunesetlenumerique.fr/

Constraints on the lexicons of human languages have cognitive roots present in baboons (Papio papio)

Scientific background

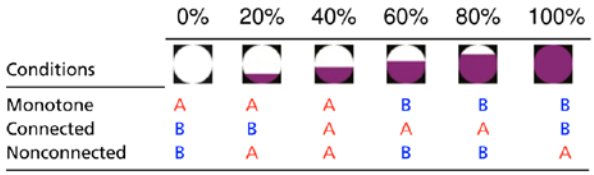
Human languages vary widely in the forms and meanings of their words. Yet, these surface differences mask numerous commonalities, including that the words in the world's natural languages are generally connected. For example, the set of all flying, feathered animals is a natural group, for which many languages have a single word (e.g., "bird"). However, the set of objects that are either red or a bird is not a natural group— it is too disconnected (e.g., it includes both raspberries, which are red, and blue jays, which are birds, but not blueberries, even though blueberries are, intuitively, "between" raspberries and blue jays) and indeed no language has a single word meaning "red or bird". A natural hypothesis is that the source of the regularity of the world's lexicon is a learning bias for connectedness. Can a bias for connectedness be found independently of language proper, and do non-human animals show such a bias? We report on an experiment with baboons that investigates these questions.

Method

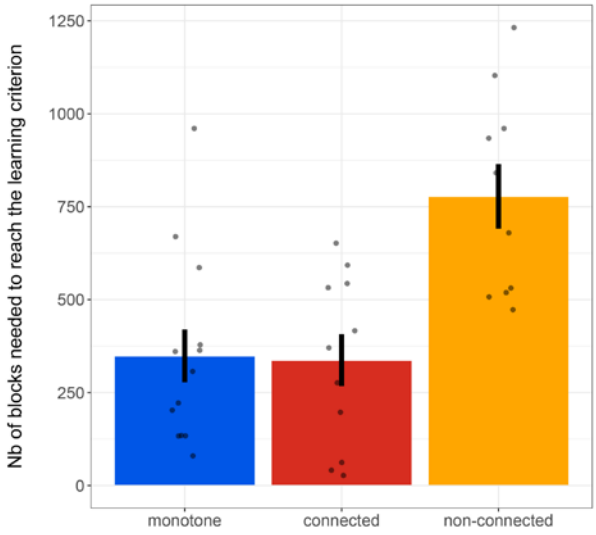
Baboons' task was to learn a rule where half of the six stimuli in a set correspond to a response A and the other half to a response B. Stimuli were pictures of bi-color circles that could be identified by their proportion of color (0, 20, 40, 60, 80, or 100% of purple; see Table 1). 14 baboons were tested in 3 conditions. In the "monotone" condition, the three stimuli associated with A were clustered at one extreme (and the stimuli associated with B were thus clustered at the other extreme). In the "connected" condition, the three stimuli associated with A were all contiguous, but not clustered at an extreme. Finally, in the "non-connected" condition, the three stimuli associated with A were spread non-continuously, and so were the stimuli associated with B.

Results

Baboons find it easier to learn connected rules compared to non-connected rules: They learn faster a rule like « between 40% and 80% of purple » (Figure 1 – « connected condition ») than a rule such as « 30% of purple or 100% of purple but nothing else » (Figure 1 « non-connected » condition)



Stimuli and Conditions



Results: Time to learn each condition/rule

General discussion

The current baboon result thus suggests that the cognitive roots responsible for regularities across the content and logical lexicons of human languages are present in a similar form in other species.

For further information
---
https://www.pnas.org/content/116/30/14926

COBRA Conversational brains

UMR 7309 • CNRS • AMU
PAROLE ET LANGAGE

Scientific background

COBRA is funded by the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement.
The purpose is to characterize and model the linguistic, cognitive and brain mechanisms that allow conversation to unfold. This project, managed by the Laboratoire Parole et Langage, includes 10 world-level academic research centers on language, cognition and the human brain as well as 4 non-academic partners that include fast- developing SMEs (Furhat Robotics, DAVI, Readspeaker) and one world-level company (Orange).

Method

A series of studies using techniques for understanding conversation are planned. Among these are:

- analyses of interactional multimodal human-human and human-machine works with extraction of acoustic indices, linguistic forms and visual information,
- interactive tasks with artificial agents,
- joint-perception experimental paradigms,
- dual EEG recordings (EEG hyperscanning),
- fMRI recordings while participants are engaged in different interactive and/or collaborative language games,
- dual motion-capture systems,
- dual electromagnetic articulography.

A dual electroencephalographic recording (EEG).

Results

- Modelling interactions on the linguistic, physiologic, cognitive and cerebral levels
- Contribution to the study of sound-to-meaning relationships
- Contribution to the emerging field of hyper-scanning by exploring the neurophysiological correlates of phonetic convergence during conversations
- Improvement of already-existing virtual agents
- Development of dialog systems with high-quality synthetic voices and high-level conversational skills

Face-to-face with the Furhat robot developed by Furhat Robotics and allowing better control of the interlocutor's responses.

For further information
---
https://www.cobra-network.eu/
noel.nguyen@lpl-aix

RUGBI, Looking for Relevant linguistic Units to improve the intelligibility measurement of speech production disorders

Scientific background

Speech production disorders, which can result from neurological disease, cancer or trauma, can lead to a loss of intelligibility making it difficult for patients to communicate with their environment and limiting their professional and/or social life. Today, improving the quality of life of patients is the central objective of care and involves maintaining oral communication. Assessing intelligibility is therefore a key element. However, traditional assessment methods, based on the perceptive evaluation of speech disorders, are only partially effective according to clinicians. The ANR RUGBI project (2019 - 2023) aims to complement therapists' tools by providing them with non-invasive, timely and affordable care. RUGBI proposes to combine perceptual and automatic measures to identify relevant acoustic and prosodic units and appropriate assessment tasks to evaluate the degree of communicative impairment or loss.

Method

The contribution of deep neural networks in the search for acoustic-phonetic units involved in the intelligibility of normal speech and, consequently, in its loss in speech disorders in patients suffering from neck and head cancers or Parkinson's disease is the aim.
A 3-step methodology, inspired by the work of [Nagamine et al.., 2015] is: 1) the study of a CNN (Convolutional Neural Network) trained to classify phonemic units from normal speech and model these units based on neuronal activation in the different layers, 2) the transfer of this model to a task for predicting speech intelligibility in the presence of normal and pathological speech, 3) the identification of the contribution of phonemic units to speech intelligibility and its variation, improvement, or alteration.

Results

Step 1, the CNN learning for classification of speech in French into phonemic units was evaluated in healthy subjects and cancer patients. Classification rates were compared with perceptual measures of the degree of speech impairment (severity measure) and the level of intelligibility/comprehensibility of the speakers (intelligibility measure) given by a jury of clinical experts.
Pearson's correlation coefficients of 0.91 and 0.78 show the relevance of the CNN (Figure 1 for the intelligibility measure).
We have started the phase of observation and interpretation of the role of the different layers and neurons in the task of modelling the distinctive features of French phonemes (Figure 2).

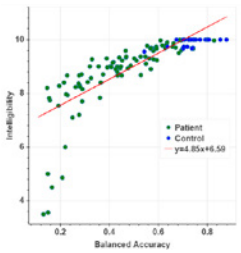


Fig.1: CNN classification rate vs. perceptual measure of intelligibility

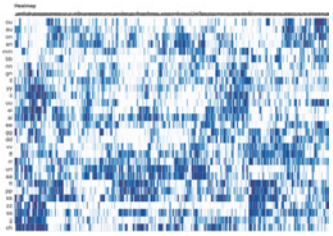


Fig.2: Activation map of the neurons of the last layer of the CNN after application of hierarchical clustering

For further information
---
corinne.fredouille@univ-avignon.fr
sondes.abderrazek@univ-avignon.fr
http://www.irit.fr/rugbi/

Reading printed books and e-books: What impact on text comprehension ?

LABORATOIRE DE NEUROSCIENCES COGNITIVES

Scientific background

Reading long texts is usually done with a book that has to be manipulated. You read with your eyes, but also with your hands. However, more and more often books are digital and are not read in the same way as printed books. Can these changes in body interaction between the reader and the book influence understanding of the text?

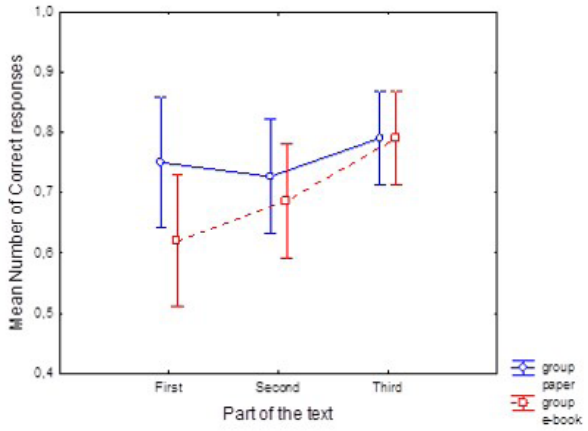
Method

50 adult subjects (average age 24 years) read a story from a collection of short stories (28 pages, 10800 words) in 2 different formats: a printed book (N=25), an e-book (Kindle Amazon) (N=25).
After reading (1 hour on average), the reader was asked a series of questions about the text and the story:

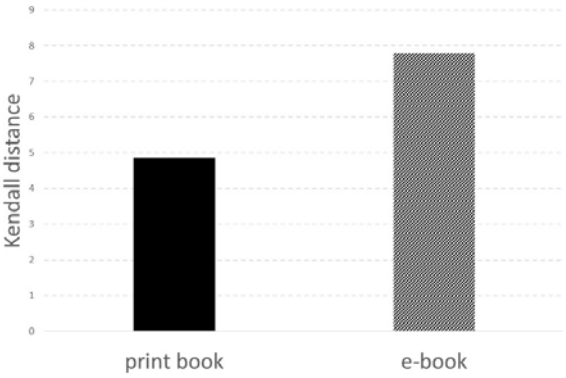
- Word and sentence recognition,
- Questions about the story (places, characters...),
- Locate events in the text space,
- Organize 14 events in the order of their appearance in the story

Results

There are no differences between the printed book and the e-book in the recognition of words, sentences and answers to questions about the story.
The localization of events in the space of the text and the reconstruction of the chronology of the story is more accurate in those who read the printed book.



Localization of the events in the 3 parts of the text by the 2 groups of readers.



Difference between the exact chronological order and that given by the 2 groups of readers (printed book and e-book)

General discussion

Overall comprehension is not different with the two types of books, but readers can better locate themselves in **the space of the text** and **in the time of the story** when reading a printed book. The sensory-motor interactions that the reader has with the physical medium of reading can play a role in the comprehension of a long text, especially narrative texts in which the chronology of events is important.

For further information

Mangen A, Olivier G and Velay J-L (2019) *Comparing Comprehension of a Long Text Read in Print Book and on Kindle: Where in the Text and When in the Story?* Frontiers in Psychology. 10:38. doi: 10.3389/fpsyg.2019.00038

Research partnerships

The Cognition Institute's 2019 directory of scientific research would be incomplete without reference to the intense contractual research activity. We have chosen to illustrate the 126 research contracts by presenting a subgroup that does not claim to be representative or emblematic. These are just a few examples to illustrate the mobilization of the 737 permanent FTEs and 1,058 non-permanent FTEs from the Institute alongside partners from the social and economic world, thus contributing to their competitive innovation.

Effect of phonological awareness training with Graphonémo software (MagikEduk) on the recognition of pseudowords in the first year of primary school

Market segment: Schools and practices (speech therapists)

Industrial context

MagikEduk is a young start-up company that has developed a software to help children in kindergarten and first grade learn to read. The software's learning path is dynamic and adapts to each reader. Thanks to artificial intelligence, the game considers the learner's level and learning strategies. The software is distributed by MagikEduk to schools and speech therapy practices, among other users.

Objectives

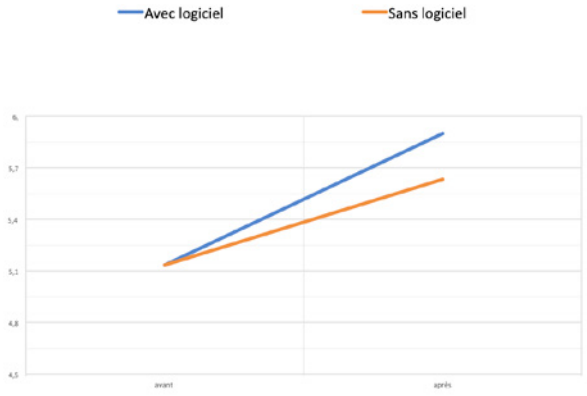
The aim here is to develop a research program based on the adaptive software Graphonémo, which, through a pedagogical scenario (serious game), helps kindergarten and first grade (preparatory course) pupils acquire and develop decoding skills. To this end, various exercises, including phonological awareness training (deletion, syllabic cutting, syllabic discrimination), are proposed and tested experimentally.

The objectives of the studies conducted by the CHArt-UPEC team are:

1. To evaluate the added value brought by the software and its gamification compared to classical exercises.
2. To better understand the influence of the exercises proposed by the software on the decoding and comprehension processes.
3. To propose differentiated courses according to the level and learning strategies of the students.

Results obtained/expected

A pilot experiment showed that in first-year students, training in phonological awareness with the Graphonémo tool favored the development of the decoding process as assessed by a pseudoword recognition test.
This first result is encouraging and justifies continuing study and development of GraphoNemo.



Effect of training with the Graphonémo software on the pseudoword recognition score (out of 6 points), in first year primary school pupils.

Scientific and technical managers

Denis Alamargot et Xavier Aparicio (CHArt-UPEC) - Sandrine Grégoire (MAGIK EDUK)

Study of the physiological and cognitive impact of a work surface inclined at 3°

INDUSTRIEDESIGN

Market segment: Design and conception of industrial furniture

Industrial context

Created in 1989, IndustrieDesign is an industrial design consultancy specializing in the design and manufacture of highly technical furniture. In 25 years, IndustrieDesign has become the French leader in the financial trading room sector.

Objectives

To measure the impact of a 3° inclination of the work surface in a seated position on cognition and spontaneous posture. The study consists of measuring i) the posture (motion capture) spontaneously adopted by the user, ii) the functioning of visual cognition (e.g., certain visual biases), iii) the functioning of sensory-motor relations when an operator interacts with a computer, and iv) concentration and focusing abilities.

Results obtained/expected

- Construction and implementation of experimental protocols
- Data processing and statistical analyses
- Drafting of a communication document aimed at professionals in the sector

Motion capture device used in the study

The results of the study showed that the 3° inclination of the work surface:

- improves posture by straightening the spine which reduces stress.
- improves vision by making the visual system less sensitive to defects in the visual environment.
- improves sensory-motor connections when the operator has to interact with a computer.
- improves the ability to concentrate and focus. Attention is more efficient.

SCALab
SCIENCES COGNITIVES ET SCIENCES AFFECTIVES

Scientific and technical managers

Sparrow L. and Deplancke A. (UMR SCALAB, Univ. Lille) - Rudolf A. (INDUSTRIEDESIGN)

PAU, Universal Access PC

Market segment: College Students and Professionals who are blind or partially sighted

Industrial context

The Universal Access PC aims to facilitate digital access for blind and visually impaired people. It is based on the Linux environment and technologies under free license. Alongside software and configurations facilitating accessibility, the development of the Tactos software offers tactile perception of spatial information on the screen: layout of elements and windows, pattern recognition (mathematical figures), map reading, etc.

Objectives

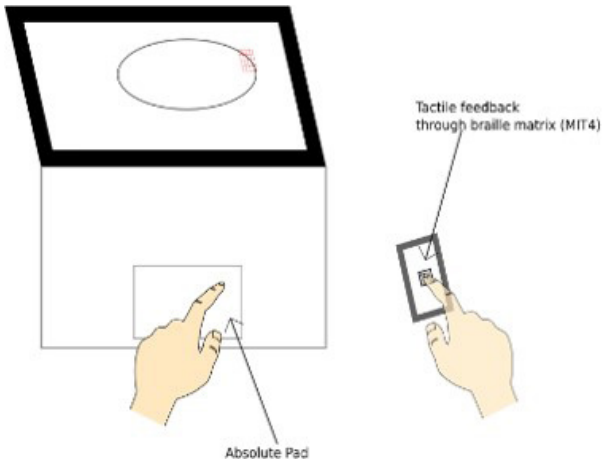
The principle of the Tactos software consists of reading the screen pixels located around the mouse pointer. Depending on the color of the pixels, the software will raise or lower the pins of the corresponding module. By coupling the movement of the hand and the return of the touch module, the user is able to find and recognize the shapes on the screen. Additional information can be sent through a text-to-speech system.

Results obtained/expected

Integration of the Tactos software in the universal access PC, via the UTC Braille controller or a commercially available strip.

Video example : https://tactos.oiseauroch.fr

Tactile interaction module



Principle of the Tactos software

Scientific and technical managers

Labo : COSTECH http://www.costech.utc.fr/
Entreprise : www.hypra.fr - contact@hypra.fr

StoryTANK

Market segment: The creative industry-Cinema

Industrial context

Groupe Ouest is a European film laboratory which, through cooperation and encouragement of innovation, aims to support film creation.
The laboratory explores new approaches to facilitate story construction: coachings authors to find their "footprint", supporting the birth of meaningful stories, decoding architect's plans for a strong film. It is a unique place in Europe dedicated to coaching authors in residence and monitoring script development.

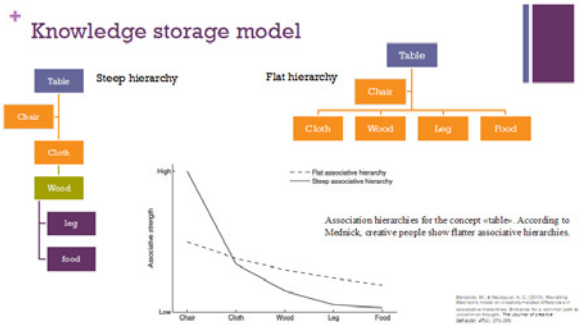
Objectives

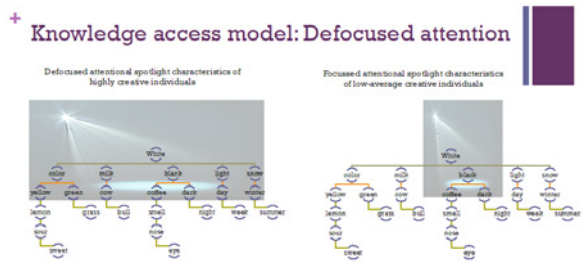
In 2019, Groupe Ouest launched the first workshop called StoryTANK in partnership with 15 institutions*. StoryTANK's objective is based on applied research workshops bringing together researchers in cognitive sciences, human sciences, physiology of emotions, etc. and storytelling practitioners, scriptwriters and script- doctors, to find together new angles to tackle both the birth of stories and the function of narrative in a disturbed humanity. LaPEA participated in the first StoryTANK and was represented by Samira Bourgeois-Bougrine who worked in the ANR CREAPRO project on the creativity of scriptwriters. She provided insights from the perspective of neuropsychology of creativity and is now exploring future research questions on cognitive enhancement around storytelling with members of the Groupe Oeust and academic colleagues including Margaret McVeigh from Griffith Film School - Griffith University-Australia.

Results obtained/expected

Around three central themes of the ThinkTank (Generation of ideas, physiology of the spectator, anthropological function of the contemporary narrative), twelve 1-hour video segments resulting from recordings of exchanges between researchers and scriptwriters will be generated.
Each of these segments will be posted on the StoryTANK's Youtube channel (starting June 2020), and each should generate at least ten "video capsules" of 2 to 3 min. on sub-topics of the segment (e.g. the multiplication of ideas).

These 120 video capsules will be posted on the social networks of each of the 15 partners (in 10 European countries) and relayed by each of the Media Antennas of the European Union throughout the year. We estimate that a minimum of 50,000 cultural and research professionals will be reached by these videos (the total audience reached by all our partners exceeds 500,000 people).





Scientific and technical managers

LaPEA : Samira Bourgeois-Bougrine
Groupe Ouest (*in partnership with Prix du Scénario (ex-Sopadin), the CNC, ARP, Europe Créative - MEDIA programme and le Film Français, as well as the European programme LIM | Less is More, Control N and TIFF in Romania, VAF in Flanders, KBF in Poland, LFC in Lithuania, NFI in Norway and the North Macedonian Film Agency; and in the presence of representatives of European programmes such as TorinoFilmLab in Italy, ACE Producers based in Amsterdam and MidPoint in the Czech Republic)

Benefits of cultural self-efficacy

Market segment: Business consulting

Industrial context

In the current global marketplace interactions between people from different cultures are more frequent. Human Resource Management consultants - such as LabRH - must be able to draw on scientific work to give advice to companies on how to facilitate these interactions.

Objectives

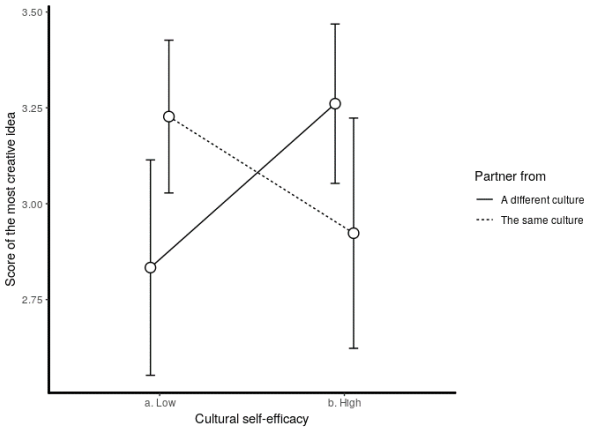
Through a first series of correlational studies, we aimed to understand the link between cultural self-efficacy and expatriation intentions among business school students.

Through a second series of studies - one involving bicultural dyads and the other an experimental manipulation of the level of cultural self-efficacy - we aimed to study the link between cultural self-efficacy and collective creative performance in an intercultural context.

Results obtained/expected

The first set of studies is published in a peer-reviewed journal (doi: 10.1007/ s10775-019-09396-1) and the other set of studies is currently being reviewed in another peer-reviewed journal.

Legend: Cultural self-efficacy and expatriation intentions



Legend: Cultural self-efficacy and creative performance

Scientific and technical managers

Todd Lubart et Martin Storme (LaPEA), Ana Camargo (bourse CIFRE) et Jean Pralong (LabRH)

Study of attention fluctuations in TGV (train) conductors

Market segment: Safety, Reliability, Human-System Interaction

Industrial context

The level of automation of High Speed Line (HSL) driver's cabs is increasing:
During a journey, a period of high attentional load on a conventional line (LC) is followed by a switch to high- speed lines, and this can lead to a long period of time in a more passive position for the operator, who becomes the "system supervisor". But increased vigilance may be required at different points in the HSL. How does the conductor regulate these variations? Could monotony lead to a drop in attention and alertness?

Objectives

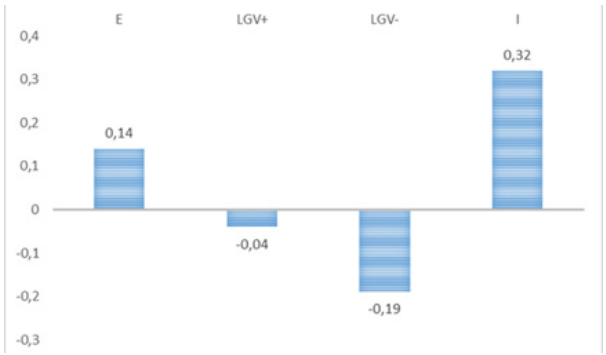
An exploratory study of 13 experienced conductors: To develop a methodology to determine the level of attention at different times for a given trip. Test eye tracking techniques in the railway environment and pupillometry techniques on a train simulator. Collect and analyze (i) objective and (ii) subjective data: (i) eye fixations and saccades, blinks, pupil size; (ii) attention and perceived cognitive load scales.

TGV conductor tasks: In a natural situation and in a simulator.

Results obtained/expected

Pupillometry and conductor self-assessments have been shown to be sensitive to changes in driver attention span. These results show that monotonous conductor situations with a low workload can lead to cognitive underload and difficulties in maintaining attention.

Capturing eye movement in the TGV driver's cab



Average variations in pupil diameter (in millimeters) of conductors as a function of period (E vs LGV+ vs LGV- vs I).
E and I being the highly charged phases

Scientific and technical managers

Jean-Michel Boucheix, Marine Lévéillé, LEAD-CNRS, UMR 5022 , Nicolas Renoir, Olivier Salvon, SNCF / DIR TECHNOLOGIES INNOVATION ET PROJETS GROUPE / IR DEP MODEL EXPER VOY

Assessing the relevance of a virtual/cognitive assistant for the TGV in GoA2

Market segment: Innovation and Research, Railways

Industrial context

Conducting on the high speed lines (LGV) is a particularly routine activity. Little by little, different degrees of conductor autonomy will be experimented with in rail transport to improve timetable reliability, to reduce carbon footprint, to increase transport speed and passenger comfort.
The first level of autonomy to be deployed on the LGV will be the GoA2 (Grade of Autonomy 2), which consists of automating the acceleration/deceleration phases on the track, with the conductor remaining in the cab to manage other operations, in particular opening/closing the doors. In this context, the SNCF is questioning the need to design and implement a cognitive assistant in the cab of the TGV GoA2 driver's agent. The question is prospective because the GoA2 is not yet deployed on the TGV.

Objectives

The objectives of the research project are twofold:

- To understand the current professional activities of TGV conductors and to project probable future activities on TGV GoA2 ;
- To grasp the conceptual object "Cognitive Assistant" in order to identify its possible contributions and limits in the industrial context described above.

Results obtained/expected

The results are divided into 3 complementary deliverables:

- **Deliverable 1:** Scientific, industrial, and technological watch on the theme of "virtual and/or cognitive assistants" and related fields. The risks related to the autonomous train, the relevance of AI and cognitive computing for efficient human-system collaboration, examples of cognitive assistants in the automotive/aeronautical/medical industries were presented.
- **Deliverable 2:** Synthesis of the co-creative approach (type C-K) to identify the most relevant cognitive assistant solution(s). Results of brainstorming and illustration of the C-K tree which make it possible to identify cognitive assistants for SNCF, list of main functions and criteria for the definition of a future cognitive assistant are presented.
- **Deliverable 3:** Two summary sheets present the research approach if the SNCF wishes to prototype a cognitive assistant. Two action plans correspond to the deployment of 2 complementary cognitive assistants, one of which can be deployed in the short term.

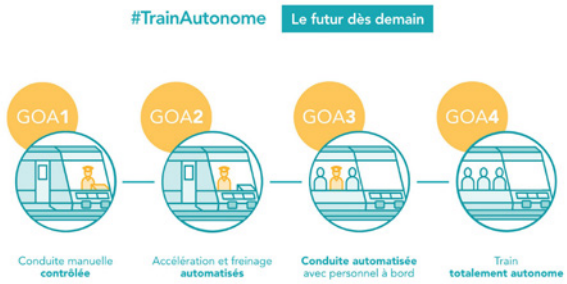
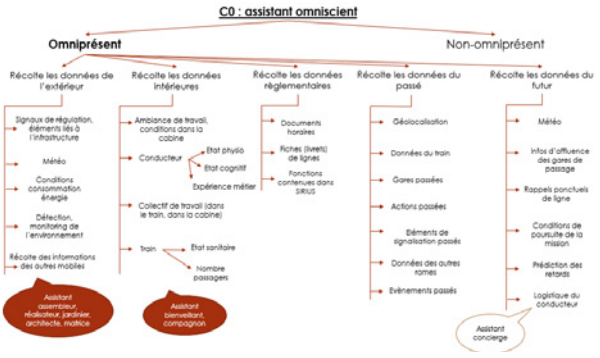


Illustration of different degrees of railway autonomy (GoA2)



C-K tree obtained at the end of the co-creativity workshop

Scientific and technical managers

Jean-Marc André (IMS, Groupe Cognitique),
Lisa Créno (ERSYA) et Cyril Cappi (SNCF)

Polyglot Models for Low Resource Automatic Speech Translation

Market segment: AI, Web and Social Networks

Industrial context

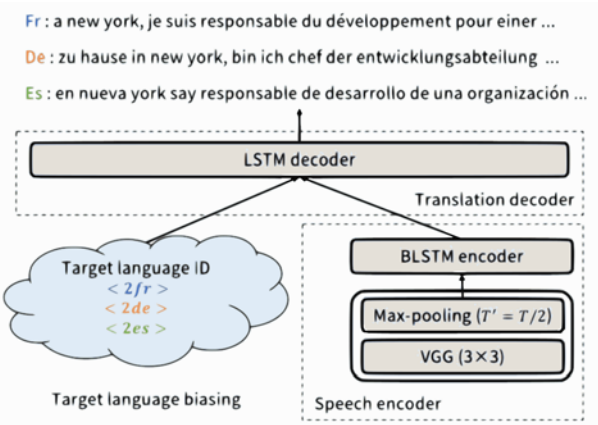
Machine translation (MT) is essential for connecting people who speak different languages. Although deep learning methods have recently accelerated the progress of Natural Language Processing (NLP), systems are still limited in speech translation because it is not possible to translate speech directly into the target language. In this task, the large amounts of annotated data required are not readily available.

Objectives

The aim of this project is to advance the state-of-the- art of end-to-end automatic speech translation. Such systems translate speech from a source language into the target language without an intermediate representation, such as transcription, in the source language. For such a task, training data is limited and the aim of this project is to take advantage of multilingual learning which should be particularly beneficial in low-resource scenarios.

Results obtained/expected

- Creation of databases with a large number of source and target languages
- Multilingual training and transfer learning approaches for low-resource machine translation of speech
- Learning with few or no direct examples of speech translation (“few shot” and “zero shot” learning)



An example of multilingual speech translation architecture

Scientific and technical managers

Laurent Besacier et Didier Schwab, LIG
Juan Pino, Facebook Applied Machine Learning

Development of implicit measures for predicting purchasing behaviour

Market segment: Transverse

Industrial context

Research institutes are interested in understanding motivations, decisions and behaviors of consumers and users. Consumer research has seen a growing interest in measures that allow such information to be collected without the consumer expressing it intentionally.
Market Vision, a marketing consultancy specializing in Consumer-Shopper decision logic, is aware of this growing interest in alternative quantitative and non-declarative methods.

Objectives

The objective of this work is to develop innovative quantitative methods adapted to consumer research to refine understanding and predict purchasing behavior. The theory of embodied cognition explores a subject's capacity for bodily actions when interacting with his environment. We can consider that a consumer perceives his consumption environment according to potential actions offered by products. Our hypothesis is that the socio-affective effect of a product influences consumer action. Thus, measured body indices should allow inference of the internal state of a consumer.

Results obtained/expected

1. Socio- affective variables such as self-esteem and social anxiety modulate the way individuals perceive space, e.g., openness. This type of data could eventually be used to evaluate the socio- affective effect of a product.
2. Mouse movement when consumers were asked to perform a dichotomous categorization task showed that consumers prioritize certain characteristics relating to the identity of a brand. This type of data could eventually be used to predict purchasing behaviour.

Illustration of the experimental procedure during a study of mouse movement.

Scientific and technical managers

Martial Mermillod et Richard Palluel-Germain
Candice Francois, Market Vision

Reducing prejudices about disability in the workplace: tools for the company

Market segment: Adult education and training

Industrial context

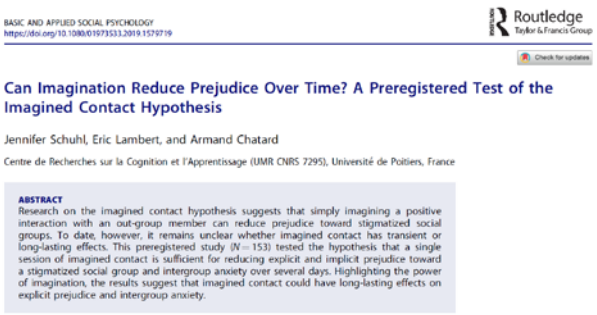
GRDF is a major French gas distribution company that wishes to promote an ambitious social policy. The human resources department will make various commitments to improve measures favoring the professional inclusion of people with disabilities. Within companies, many prejudices hinder this inclusion and these sometimes unintentionally create discrimination which GRDF aims to effectively combat.

Objectives

Stereotypes and prejudices sometimes play an important role in decision-making and are difficult to combat. In social psychology, theories on intergroup relations propose apparently effective solutions. However, few studies have been carried out in a professional context. The objective is therefore to propose more or less immersive situations to employees and to test the effects on the reduction of prejudices regarding disability, including psychological disability which has the most negative perception both in society and in employment.

Results obtained/expected

Intergroup contact theory is effective in reducing prejudice. Modes of contact other than face-to-face contact are possible, such as imagination or role-playing. These so-called “imagined” and “embodied” contacts have not been well tested in companies. The aim of this work is to create and test effective company training tools, such as MOOC-type e-learning training and awareness-raising workshops, to reduce stigma and judgmental bias.



BASIC AND APPLIED SOCIAL PSYCHOLOGY
https://doi.org/10.1080/01973533.2019.1579719

Routledge
Taylor & Francis Group

Can Imagination Reduce Prejudice Over Time? A Preregistered Test of the Imagined Contact Hypothesis

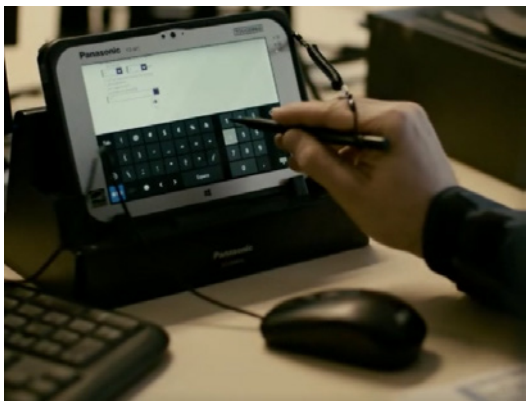
Jennifer Schuhl, Eric Lambert, and Armand Chatard

Centre de Recherches sur la Cognition et l'Apprentissage (UMR CNRS 7295), Université de Poitiers, France

ABSTRACT

Research on the imagined contact hypothesis suggests that simply imagining a positive interaction with an out-group member can reduce prejudice toward stigmatized social groups. To date, however, it remains unclear whether imagined contact has transient or long-lasting effects. This preregistered study (N = 153) tested the hypothesis that a single session of imagined contact is sufficient for reducing explicit and implicit prejudice toward a stigmatized social group and intergroup anxiety over several days. Highlighting the power of imagination, the results suggest that imagined contact could have long-lasting effects on explicit prejudice and intergroup anxiety.

Validation of interventions through the publication of scientific articles



Digital tools for training purposes

Scientific and technical managers

Doctoral student : Jennifer Schuhl (Chargée de recherche chez GRDF)
Laboratory : Centre de Recherches sur la Cognition et l’Apprentissage (Poitiers)
Scientific Director : Eric Lambert et Armand Chatard (Professeurs Univ. Poitiers)
Company : Gaz Réseau Distribution France (Paris)
Scientific manager : Hélène Benard (Responsable Pôle Diversité, GRDF)

Writing and note-taking

MyScript iink® interactive ink on users «cognitive functioning»

Market segment: Education and training

Industrial context

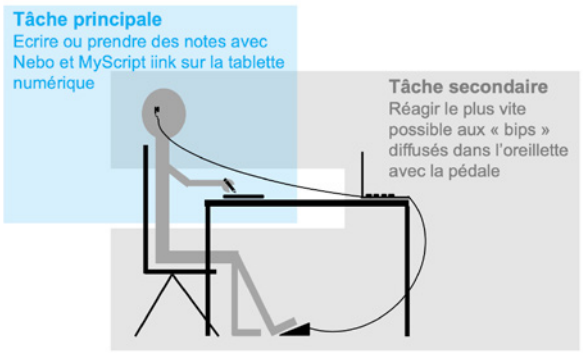
MyScript is a software publisher that developed a technology based on handwriting recognition: the MyScript Interactive Ink®.
MyScript iink® allows writing on a digital interface with a stylus. Handwriting is recognized and converted into typographical characters, erased, selected, shared and saved easily thanks to the possibilities offered by media such as tablets or smartphones. MyScript iink® is available through the Nebo® application.

Objectives

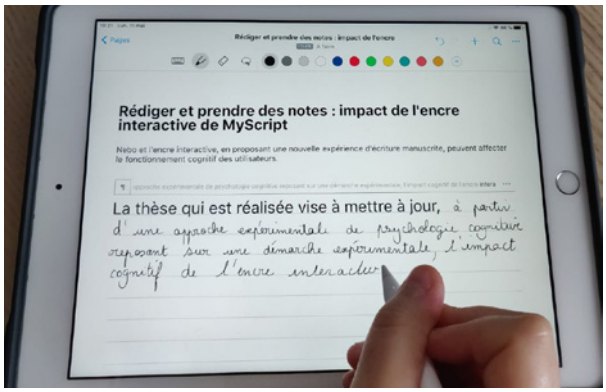
Writing is an important part of education and learning. Indeed, it is by writing and taking notes that students can understand and integrate their coursework. The Nebo application and interactive ink are a compromise between writing with a pen and paper and writing with a computer. The Nebo application allows students to benefit from the advantages of handwriting while having access to the advanced functions of computers and word processors.

Results obtained/expected

Nebo and the interactive ink offer a new handwriting experience. Our studies use cognitive and experimental psychology to unveil the impact of MyScript iink® on a user's cognitive effort.
For industry, the research will define areas of improvement for interactive ink and Nebo.



Dual task situation to assess the cognitive effort of participants during writing tasks



The Nebo application with MyScript iink

Scientific and technical managers

Doctoral student : Marie Lebrisse (UX Researcher)
Laboratory : Centre de Recherche sur la Cognition et l'Apprentissage (Poitiers)
Scientific Director : Thierry Olive (Directeur de recherche CNRS)
Company : MyScript (Nantes)
Scientific manager : Estelle Garcet (Lead UX Researcher)

Multisensory interactive table DERi

Market segment: Health and Autonomy, Education

Industrial context

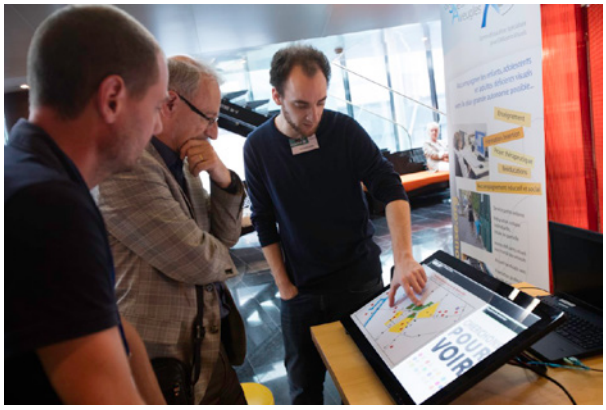
IRIT and the Institute for Young Blind People in Toulouse have developed a multi-sensory interactive table called DERi. It improves the accessibility of graphics for the visually impaired in multiple contexts: educational graphics in a school, the map of a building or an event, an educational quiz, a game board, etc.

Objectives

- Develop non-visual interactions that allow people with visual impairments to understand graphics
- Evaluate device usability and acceptability among people with visual impairments, specialized teachers, event programmers, etc.
- Develop functional prototypes for different applications - Find an industrial partner/provider for diffusion
- Find a business model to publicize the device in specialized centers, buildings open to the public, etc.

Results obtained/expected

- Several international publications in the fields of cognitive science, psychology, assistive technologies and Human-Computer Interaction and in "professional" journals.
- Three prototypes delivered (Ramonville street festival (town hall/ARTO), two special education centers: IJA and ASEI.



The DERi interactive table at the French Federation for the Blind Open House

The DERi interactive table shows a multisensory map of the city of Ramonville.

Scientific and technical managers

IRIT - Cherchons pour Voir
Institut des Jeunes Aveugles de Toulouse

Role of astrocyte connection blockade on memory performance in mice

Market segment: Treatment of Alzheimer's disease

Industrial context

Neurons in the brain are associated with auxiliary cells called astrocytes. These cells are more than neuron maintenance and protection agents, as was long believed, and instead participate in synaptic activity via their release of neuroactive substances. Connexin proteins in the astrocytes form channels involved in the release of these neuroactive substances, particularly in the hippocampus, a key region in the regulation of memory.

Objectives

- Develop new tools to genetically inactivate astrocyte connexin proteins
- Characterize the effects of shRNA directed against astrocyte connexin proteins on scopolamine-induced memory impairment.

Results obtained/expected

Intra-hippocampal injection of shRNA directed against the main astrocyte connexin proteins (Cx30 and Cx43) drastically decreased the expression of these proteins (Figure 1).
Scopolamine-induced memory disorders in mice were prevented by treatment with donepezil (Aricept®) and the genetic blockade of connexins 30/43 (Figure 2).

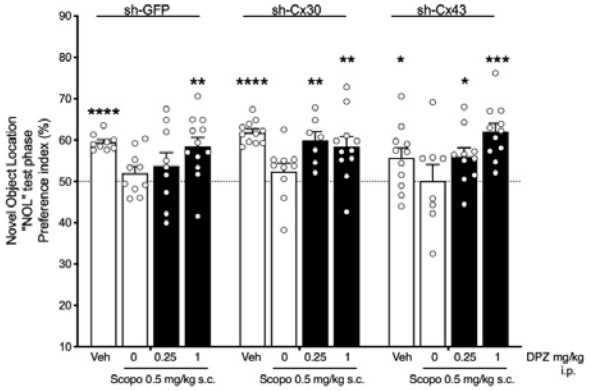


Figure 1: Validation of intra-hippocampal inactivation of astrocyte connexins using shRNA

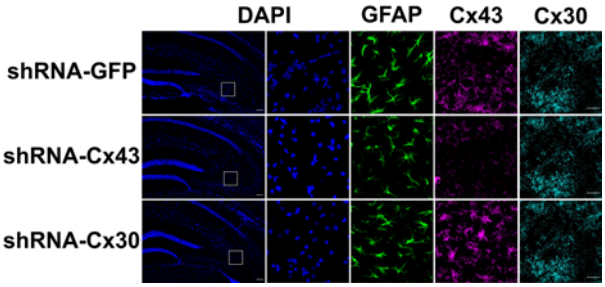


Figure 2: Effect of astrocyte connexin inactivation on scopolamine-induced memory disorders

Scientific and technical managers

Bruno Guiard (Centre de Recherches sur la Cognition Animale) et Mathieu Charvériat (Théranexus)

Effect of olfactory active ingredients on memory capacity in a chronic stress model in mice

Market segment: Treatment of stress-induced memory disorders

Industrial context

A smell can evoke a host of memories suggesting that the sense of smell interacts with neurobiological circuits controlling memory. This hypothesis is supported by the existence of anatomical and functional interactions between certain sensory brain regions (enthorinal cortex) and those involved in memory processes (hippocampus) (Fig 1). Chronic stress is known to impair memory by acting on these circuits.

Objectives

- Validate the effect of chronic exposure to corticosterone on behavioral responses associated with stress (emotion and memory) and hippocampal plasticity.
- Characterize the effects of different olfactory-active ingredients (“citrus sinensis” / “curcumin”) on stress-induced memory deficits.

Results obtained/expected

Chronic administration of corticosterone induced anxio- depressive-type effects in mice which were associated with a decrease in the maturation of neurons in the toothed gyrus of the hippocampus (Fig 2), as expected. Current experiments are evaluating the effects of corticosterone, alone or in combination with different olfactory additives, on different forms of memory.

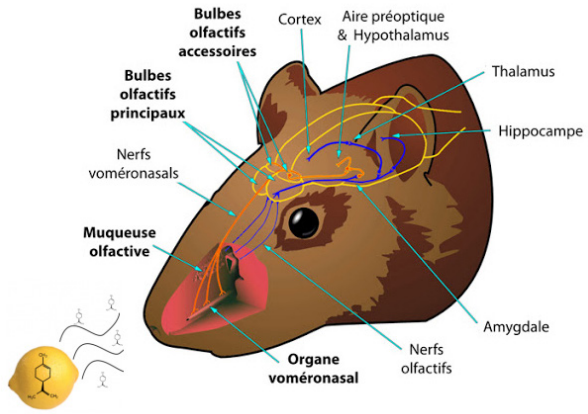
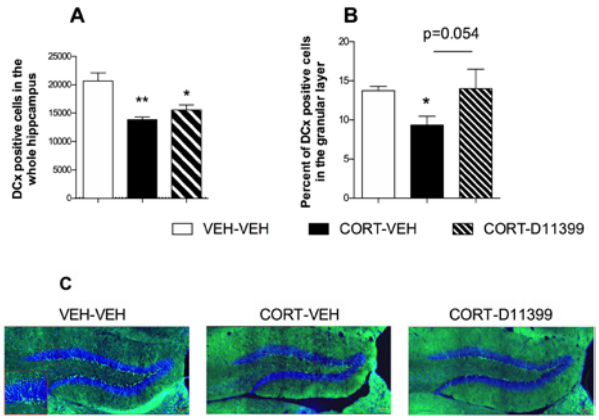


Figure 1: Diagram showing the anatomical links between the neural circuits of the sense of smell and memory



Beneficial effects of “citrus sinensis” on stress-induced behavioral and molecular abnormalities

Scientific and technical managers

Bruno Guiard (Centre de Recherches sur la Cognition Animale) et Virginie Noirot (Phodé)

Serious GaRS, Serious Game for Rehabilitation in Seniors

Market segment: Rehabilitation

Industrial context

Médicapteurs (Balma, France) develops and distributes baropometric measurement systems. A flagship product is the Win-Pod platform, which allows observation of the evolution of plantar pressures as a function of time during a test. Analysis of this data can predict the capacity of a subject to balance. Games are proposed to patients which encourage them to move their pressure center on the Win-Pod platform. In doing so, they mobilize a digital avatar and perform virtual tasks.

Objectives

A system of networked platforms based on the Win-Pod captures the plantar pressures of several subjects on their platforms. Serious Games have been developed to exploit these signals and propose collective activities based on the CRCA's work on collective cognition and group organizsation. The games are inspired by research on load transport in ants, on nectar collection in bumblebees, and on the movement of fish in schools. Patients thus perform motor, cognitive and social tasks.

Results obtained/expected

Use of the networked Win-Pod system and software resulted in significant improvement (+20%) in equilibrium compared to patients treated conventionally. Users had a positive perception of the collective game and apprehension of falling was significantly reduced by the exercises. Collective play seems to bring motor and psychological benefits but further studies are required to evaluate effects on socialization.

Training session

Scientific and technical managers

Pierre Moretto (CRCA UMR CNRS 5169 - CAB) et Éric Poirier (Médicapteurs SA)

Optimizing collective information retrieval processes in a human group

Market segment: Use of digital footprints in decision-making processes

Industrial context

In our digital societies, social influence processes are present and often exploited in electronic social networks as well as in e-commerce. Despite the development of rating and recommendation systems, obtaining reliable evaluations of services or products remains problematic.

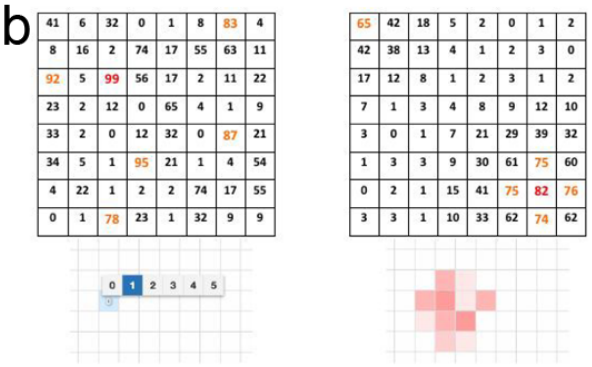
Objectives

- To understand the influence of various forms of digital traces on individual decision-making processes and their consequences in the dynamics of collective choice.
- To develop information systems to increase the capacity for collaboration and coordination within human groups.

Results obtained/expected

This project combines quantitative analysis and modeling with environmental factors that can influence decision-making to understand the influence of digital traces carrying social information on individual and collective choices. This is an essential step in the development of personalized decision support algorithms as well as artificial collective intelligence systems based on nudging.

a. Interface of the interactive web application used to analyze the influence of digital traces on collective information retrieval processes



b. Examples of number tables used in the application (on the left, a random card; on the right, a "soft" card); at each repetition, the players can deposit numerical traces on the visited squares which adopt a color whose tone is proportional to the intensity of the traces deposited.

Scientific and technical managers

Guy Theraulaz (Centre de Recherches sur la Cognition Animale) and Clément Sire (Laboratoire de Physique Théorique)

Activation of intelligent objects by pronouncing a wake-up word

Market segment: Semiconductors, smart objects, high technology

Industrial context

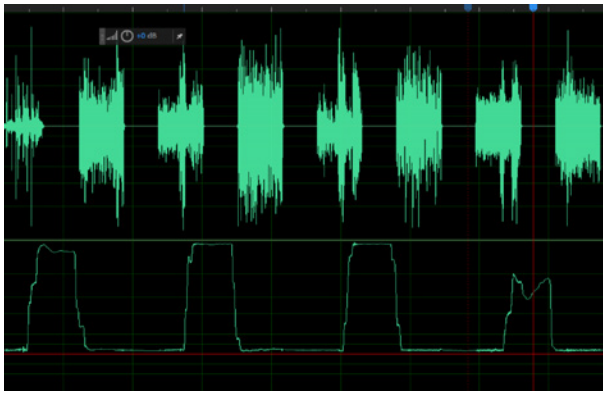
NXP is an international company that designs, manufactures, and markets semiconductors that equip a large number of high-tech devices used by manufacturers and the general public. Hardware and software innovation, research, and development are essential in this field.

Objectives

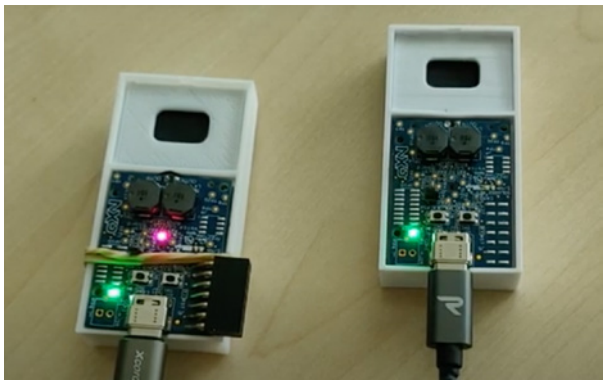
The latest advances now make it possible to study automatic speech processing systems in noisy environments. The aim of this collaboration is to design and implement a demonstrator for the activation of intelligent objects by waking words.
A challenge to noise concerns the hardware environment with constrained resources (computing power and memory) on which the demonstrator must operate.

Results obtained/expected

A competitive demonstrator was designed and implemented on NXP equipment.
It was validated according to rigorous benchmarks established by one of the major players in the field.



«Alexa» on NXP RT1060



Behaviour in noisy configuration

Scientific and technical managers

Yannick Estève (LIA) and Laurent Pilati (NXP)

GraphoGame: A digital educational tool to help in learning-to-read

Market segment: Education and training

Industrial context

Graphogame (GG) is a complete and unique IT environment (see https://graphogame.com/). The French version was developed at LPC by Johannes Ziegler and Liliane Sprenger-Charolles. The pedagogical content is presented as a series of games (see Figure for examples), broken down into teaching units developed by considering statistical properties of French orthography using psycholinguistic databases of school manuals.

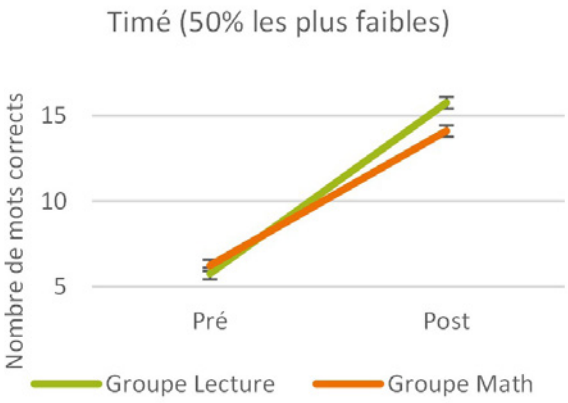
Objectives

- High quality simultaneous audio-visual presentation → COUPLING, SYNCHRONIZATION
- Immediate correction of errors → SUPERVISED LEARNING
- Follow-up of the child and adaptation to their level → INDIVIDUALIZED LEARNING
- Systematic progression, from easiest to most complex → SYSTEMATICITY
- Massive repetition → AUTOMATICITY
- Playful, the student is in a situation of success → MOTIVATION, CONFIDENCE, SUCCESS

Results obtained/expected

Large-scale validation (1,000 students) where lower-performing students (below the sample median), showed significant progress (85% of a standard deviation) in reading compared to a math intervention. Teachers gained time by delegating repetitive and tedious tasks to the computer, they could follow the children with quantitative indicators and benchmarks. The training increased the effective time that children spent on reading and decoding activities by approximately 15 hours. The software is available for free on Apple Store and Google Play.

Examples of GraphoGame

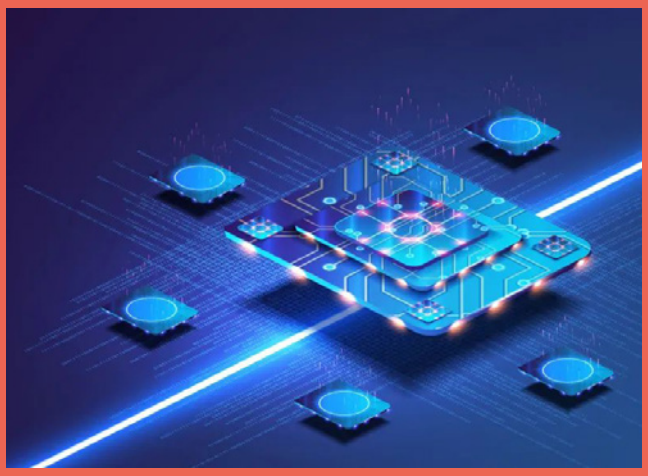


Results from a large-scale intervention study on 1000 primary school students conducted in socially disadvantaged neighborhoods of Marseille.

Scientific and technical managers

Laboratoire de Psychologie Cognitive, GraphoGroup

Artificial Intelligence



Artificial Intelligence (AI) is crucial to all the Institute's activities.

Natural Intelligence (IN in Cognitive Sciences) and Artificial Intelligence are closely coupled both from a theoretical and a functional point of view. Theoretically, AI provides tools and models to IN, which proposes sources of inspiration to AI. Functionally, IN provides evaluation methods and adaptation strategies to AI developments, which in turn provide products and services to repair, complement, and assist IN.

These two loops cross the Institute's 4 research axes.

Jean Baratgin (CHArt), Christophe Labourdette (Centre BORELLI), Jean-Luc Schwartz (GIPSA Lab), Dominique Longin (IRIT), Boris Burle (LNC), Christophe Jouffrais (IRIT), Jean Lorenceau (Fondation Cognition), Célestin Sedogbo (IMS) - Members of the Operational Board

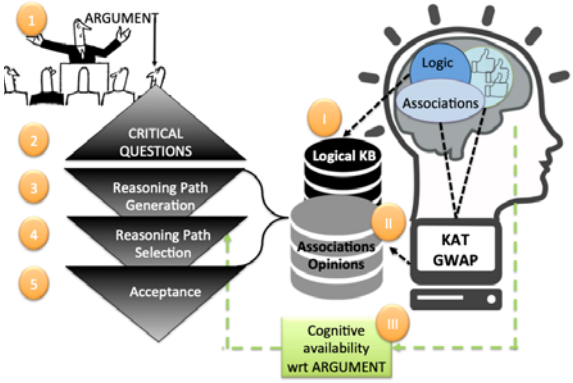
AI can only be cognitive and cognitively adapted.

The current craze for Connective Artificial Intelligence is based on the algorithmic revolution in random and neural computation, the huge amount of raw data now available and exploitable, and the power of processors.

The future view in the design of artificial intelligence engines are largely based on Deep Learning models associated with various learning paradigms (supervised, unsupervised, by reinforcement, etc.) and learning data, the quantity of which now makes it possible to design systems that converge after enormous amounts of computation. We are seeing the flourishing of systems that copy any behavior that seems human and that provide a better understanding of the ins and outs of machine learning. Understanding of the successes and limitations of algorithmic approaches paves the way for further understanding of the mechanical aspects of intelligence.

The result is a contextless supremacy of these statistical approaches. They are black boxes whose functioning is not explicit, thus raising new questions of acceptability, explanation, and confidence. North America largely dominates this trend and understands the future obstacles. They are now focusing on the new concept of white AI, i.e. mechanisms complementary to the learning machine which model the result a posteriori in an attempt to make it explainable, intelligible and acceptable to a human being.

These approaches are widely used in the public arena but they pose problems of «technical confinement»: a system developed for a given application is not easily transferable to another application. Human intelligence, however, is perfectly capable of «transferring» acquired knowledge to other fields of application, and thus generating extremely powerful cross-disciplinary insights. These developments with massive databases should not make us forget the numerous works in fields where data are less numerous, difficult or impossible to obtain, and where cooperation between artificial intelligence and human intelligence is a central issue.



Artificial intelligence in its cognitive dimension ("symbolic AI", as opposed to "connectionist AI") aims precisely at compensating for a lack of data through rules of reasoning which integrate varied results from cognitive sciences (analysis of language, emotions, intuitive reasoning, mechanisms for analyzing complex scenes, decision-making under stress, the influences of others on ourselves, etc.).

Cognitive AI returns to the fundamental alliance between computer science and psychology, and even the neurosciences. It is based on an essential experimental approach which questions human intelligence and its sensory, motor, linguistic and social capacities. In return, it is also involved in the human, social, and life sciences by providing them with models and tools essential to their development. Nevertheless, AI is in great need of data science, which is in full expansion, to transcribe behavior in a digital world.

From a historical point of view, this «renewed alliance» between AI and cognitive sciences are not only a necessary return to the original relationship. One can indeed refer to the article by Herbert Simon, historical founder of the field of AI and published in 1995 in Artificial Intelligence, the leading journal in the field.

It is this vision of artificial intelligence: cognition, which is defended by the Cognition Institute at the confluence of two trends:

- The creation of explicit models (rules, representations, etc.) in the tradition of cognitive sciences, enriched by data that significantly strengthen the learning process. The predictive power of these models, in conferring contingent explanatory power. From these explicit models reinforced by learning, data will intrinsically lend themselves to cognitive assessments of all forms, from adaptability to needs to ethical acceptability.
- The introduction of cognitive mechanisms in deep learning approaches, such as management of memory or time, thus giving AI a more natural and agile capacity for intelligence.

It's time to overcome the historical connectionist-symbolist divide and to work on a fusion of these two approaches. Data collection, the guarantee of quality and consideration of the factor must be conducted with a rigor that blends math and science.

Cognitive systems represent the future, i.e. the «next move», that of the future of AI and its real adaptation to human needs.

Cognition science and technology can allow France to become a major actor and a global emulator by its mastery of principles and technologies underlying cognitive processes.

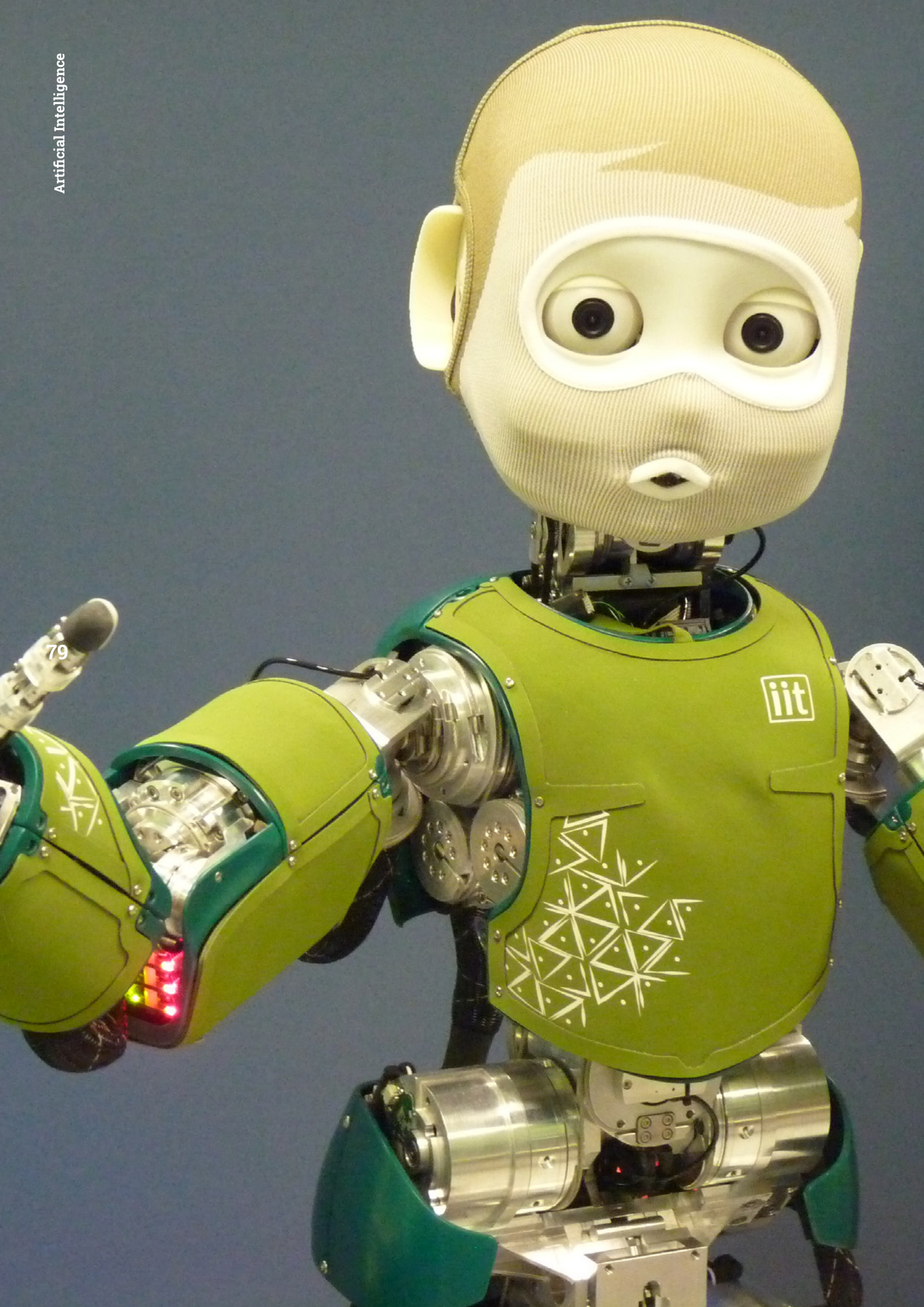
For further information

- Dupin de Saint-Cyr F., Guillaume R., Mushtaq O. *Explainable Decisions under Incomplete Knowledge with Supports and Weights.* In : IEEE International Conference on Fuzzy Systems 2019

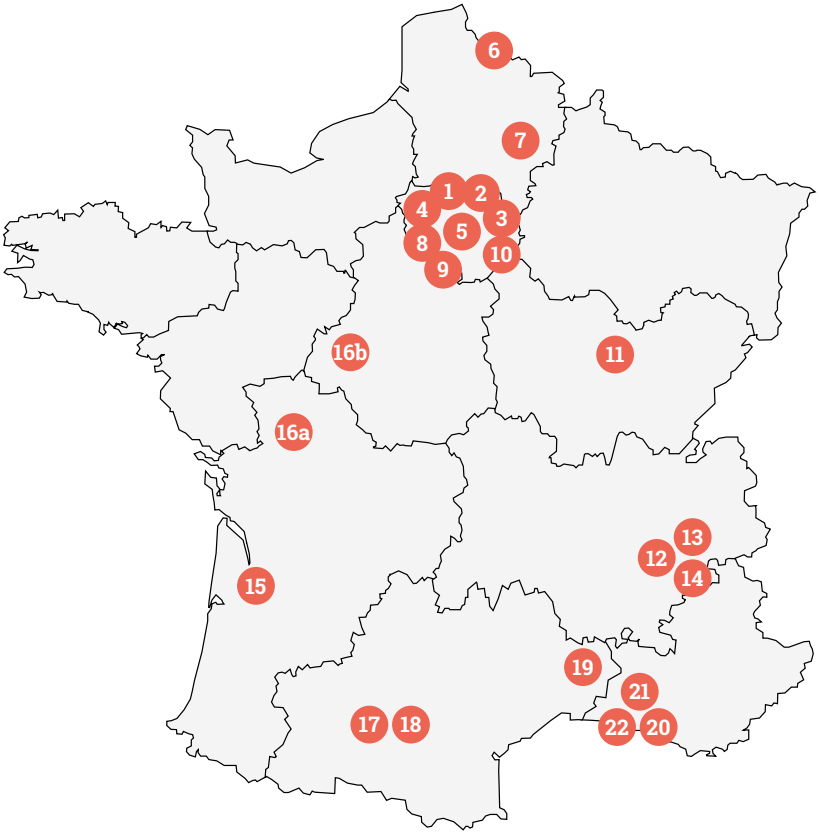
- Parmentier JF., Silvestre F., *La (dé-) synchronisation des transitions dans un processus d'évaluation formative exécuté à distance : impact sur l'engagement des étudiants*, 9ème Conférence sur les Environnements Informatiques pour l'Apprentissage Humain (EIAH 2019) p. 97—108 – 2019

- Vidal, F., Burle, B., & Hasbroucq, T. (2020). *Errors and Action Monitoring: Errare Humanum Est Sed Corrigere Possibile. Frontiers in Human Neuroscience*, 13, 453. (numéro spécial consacré au thème «Neuroergonomics»)

- C. Dubost, P. Humbert, A. Benizri, J.P. Tourtier, N. Vayatis, P.-P. Vidal. *Electroencephalogram selection of the frontal F8 channel to predict the depth of anesthesia. Frontiers in Computational Neuroscience*. doi: 10.3389/fncom.2019.00065.


iit

Our laboratories



1 **CHArt**
Laboratoire Cognitions Humaine et Artificielle, Saint-Denis

2 **IJN**
Institut Jean Nicod, Paris

3 **LSP**
Laboratoire des Systèmes Perceptifs, Paris

4 **LSCP**
Laboratoire de Sciences Cognitives et Psycholinguistique, Paris

5 **ENSADLab**
Laboratoire de recherche ENSADLab, Paris

6 **SCALAB**
Laboratoire sciences cognitives et sciences affectives, Villeneuve d'Ascq

7 **COSTECH**
Connaissance, Organisation et Systèmes Techniques, Compiègne

8 **LaPEA**
Laboratoire de Psychologie et d'Ergonomie Appliquée, Boulogne Billancourt

9 **LIMSI**
Laboratoire d'Informatique pour la Mécanique et les Sciences de l'Ingénieur, Orsay

10 **Centre Borelli**
Cachan

11 **LEAD**
Laboratoire d'Etude de l'Apprentissage et du Développement, Dijon

12 **GIPSA LAB**
Laboratoire Grenoble Images Parole Signal Automatique, Saint-Martin d'Hères

13 **LIG**
Laboratoire d'Informatique de Grenoble, Saint-Martin d'Hères

14 **LPNC**
Laboratoire de Psychologie et Neurocognition, Grenoble

15 **IMS**
Laboratoire «l'Intégration du Matériau au Système», Talence

16a 16b **CeRCA**
Le Centre de Recherches sur la Cognition et l'Apprentissage, Poitiers et Tours

17 **IRIT**
l'Institut de Recherche en Informatique de Toulouse, Toulouse

18 **CRCA**
Centre de Recherches sur la Cognition Animale, Toulouse

19 **LIA**
Laboratoire Informatique d'Avignon, Avignon

20 **LPC**
Laboratoire de psychologie cognitive, Marseille

21 **LPL**
Laboratoire Parole et Langage, Aix en Provence

22 **LNC**
Laboratoire de Neurosciences Cognitives, Marseille

Our supervision

Our institutional partners

DIRECTOR OF PUBLICATION
Célestin Sedogbo

SCIENTIFIC ENGLISH LANGUAGE EDITING
Katherine Flynn

DESIGN AND REALIZATION
Gaël Rolland

PRINTING
A.C.S.D., Bordeaux

VISUAL COPYRIGHT
Institut Cognition, Fotolia

This 2019 Yearbook was published in July 2020.
Thanks to all contributors.

In order to facilitate the reading of certain texts, we sometimes use feminine and masculine forms to designate persons. We use neutral forms as much as possible It goes without saying that we are always talking about women and men.

institut
cognition

Institut Cognition - ENSC Bordeaux INP
109 avenue Roul, 33400 Talence
+33 (0)5 57 00 67 40
contact@institut-cognition.com - direction@institut-cognition.com