FINALEMENT, C'EST LE CERVEAU QUI VOIT ! IMPACT DES TROUBLES NEUROVISUELS

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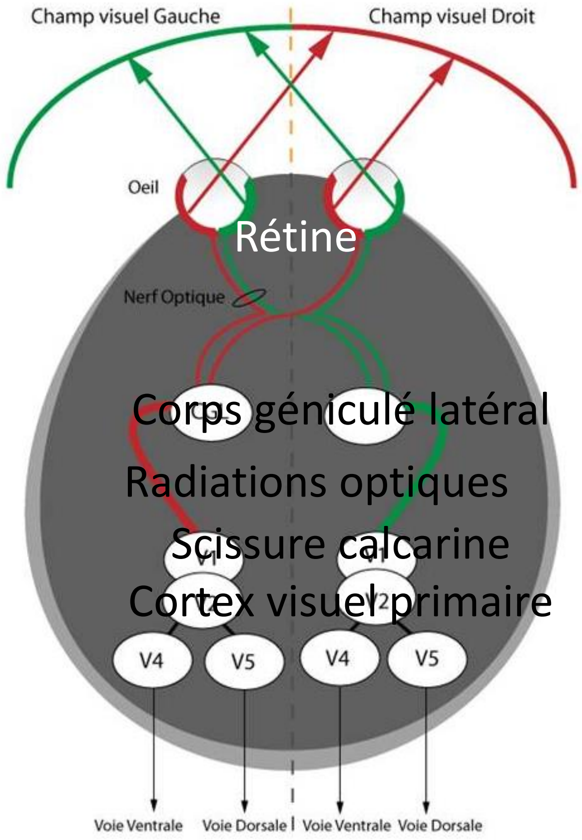
La perception visuelle du monde qui nous entoure est également rendue possible grâce à l'activité d'une partie importante de notre cerveau

- Les aires visuelles cérébrales
  - 1/3 de notre cerveau
  - Spécialisées dans un type de traitement particulier, du plus perceptif au plus cognitif
  - A la sortie de la rétine, il n'existe plus de scène visuelle à proprement parlé
    - les informations visuelles sont transmises sous forme d'influx électrique de l'œil au cerveau
    - c'est au niveau cérébral que la scène va être reconstruite en fonction des différentes informations portant sur la couleur, la forme, le mouvement, la localisation spatiale, etc.
  - Chaque hémisphère cérébral va traiter les informations issues d'un seul hémichamp
    - hémisphère droit traitera informations visuelles hémichamp gauche



LA VISION DE L'ŒIL AU CERVEAU

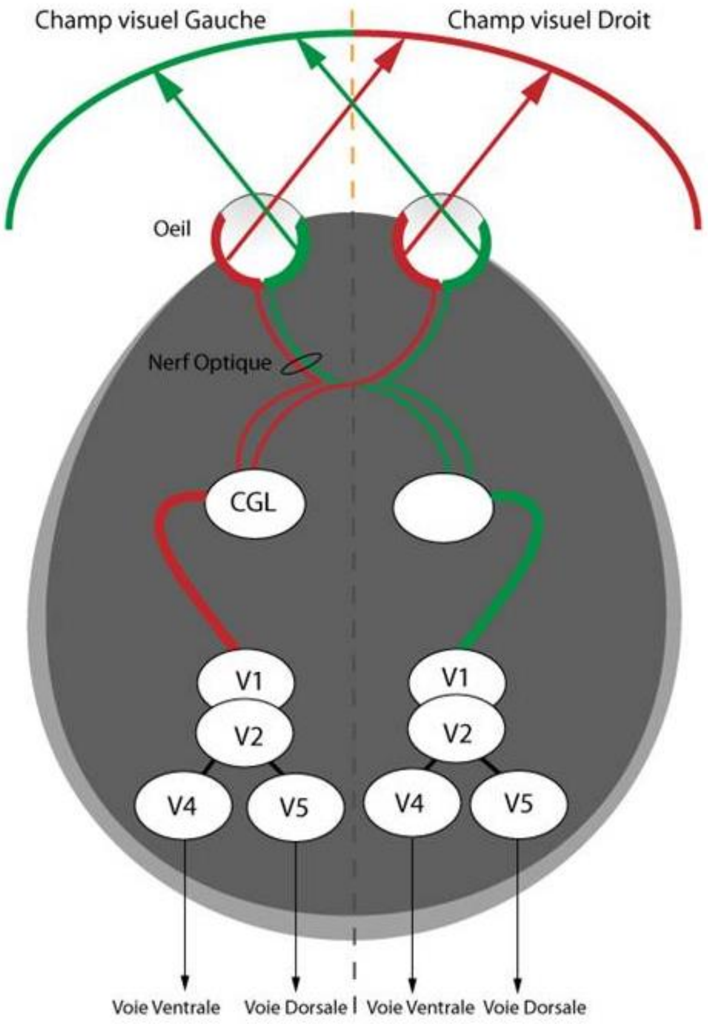
1. Champ visuel: partie de l'espace visuel couverte par la rétine d'un seul œil lorsque le regard est fixé vers un point éloigné; l'image reçue au niveau de la rétine est inversée

2. Hémichamp: hémichamp visuel gauche se projette sur la rétine temporale de l'œil droit et sur la rétine nasale de l'œil gauche et vice-versa pour l'hémichamp visuel droit

3. Seules les fibres nerveuses de la partie nasale de la rétine croisent la ligne médiane au niveau du chiasma optique pour rejoindre celles de la partie temporale de la rétine contralatérale

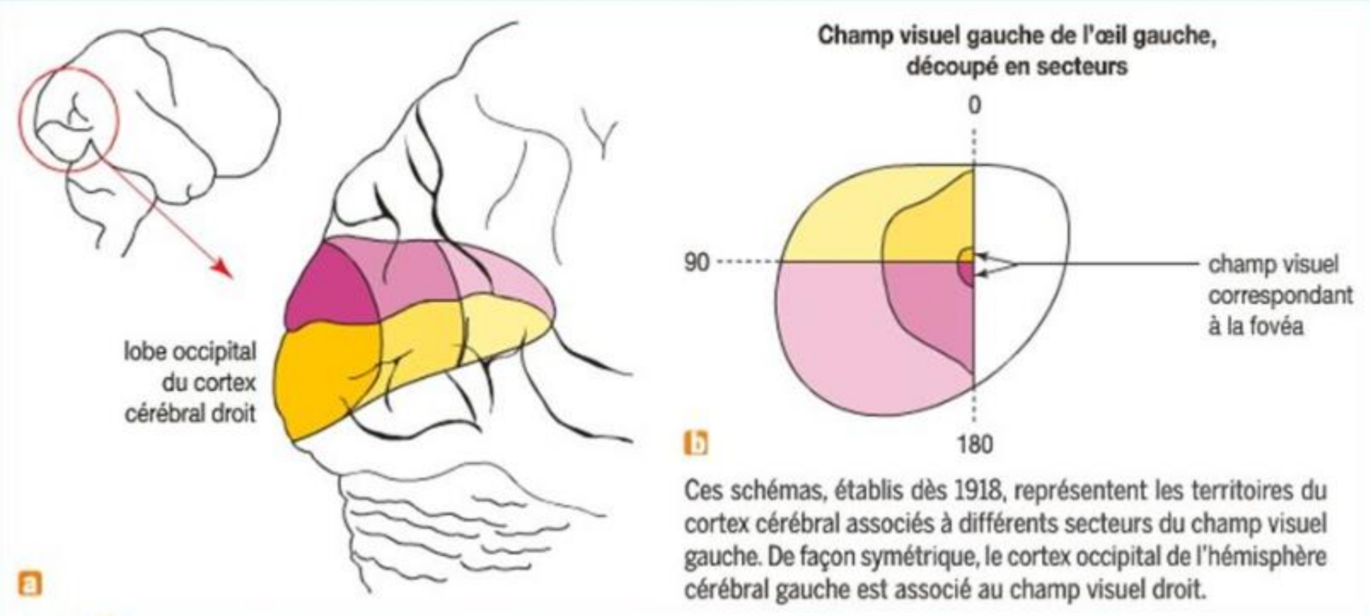
4. Les axones des cellules ganglionnaires de chaque rétine responsables de la détection de stimuli visuels dans l'hémichamp droit se retrouvent dans le tractus optique gauche et inversement pour l'hémichamp gauche

5. La partie nasale d'une rétine se projette sur le cortex visuel contralatéral et la partie temporale sur le cortex visuel ipsilatéral

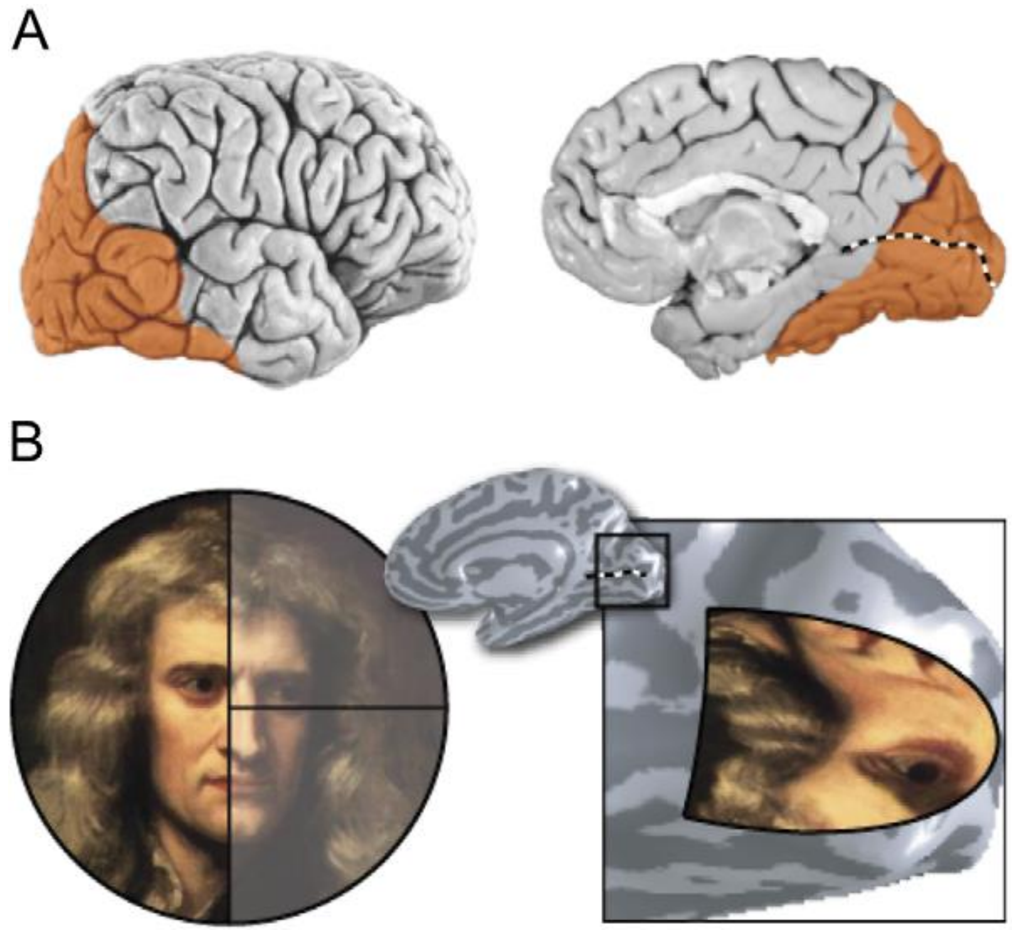


Représentation corticale au niveau du cortex visuel primaire (V1) de la région maculaire

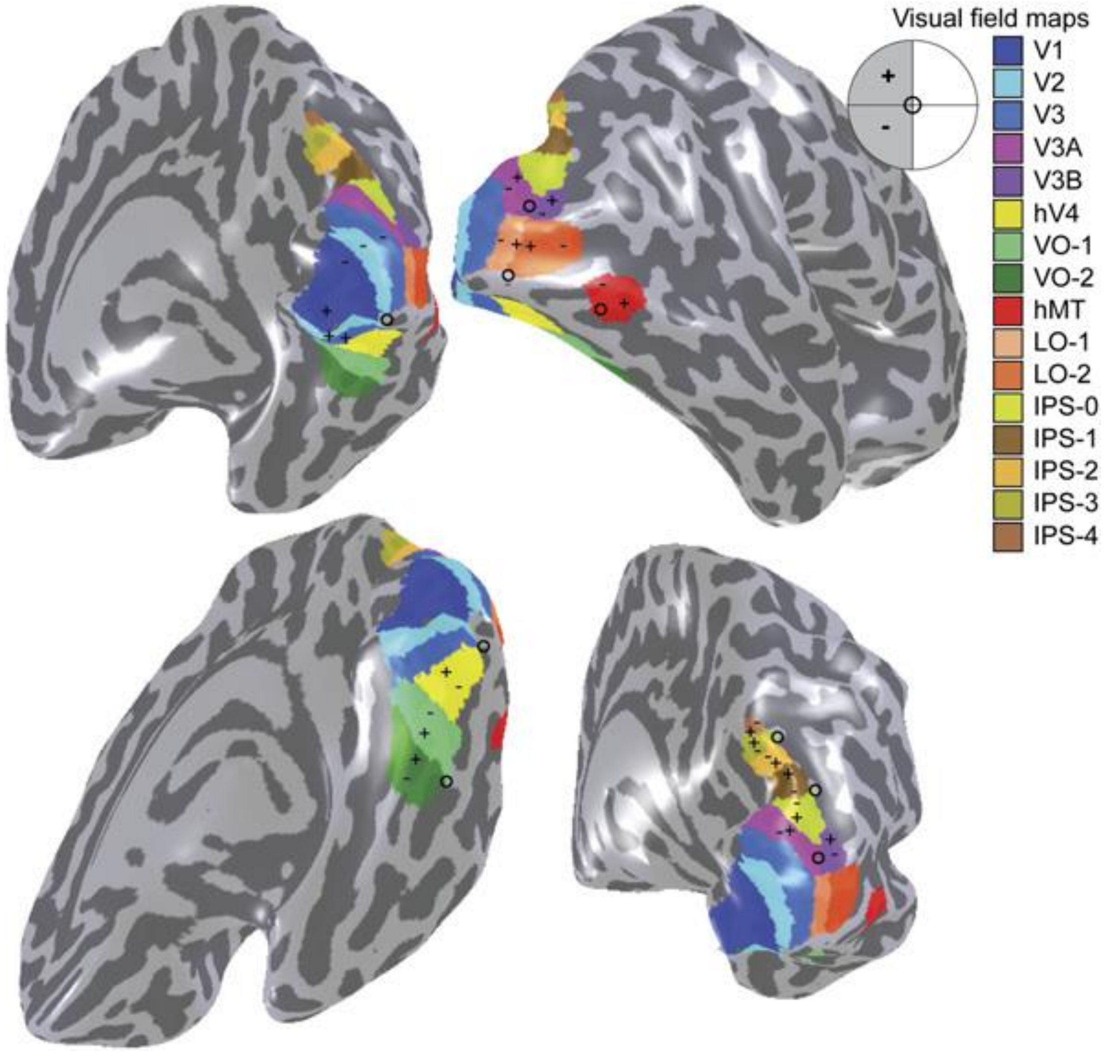
A. Cortex visuel représente 30% du cortex cérébral. C la V1 est situé autour de la scissure calcarine
A. Image champ visuel gauche sur V1 à droite: image inversée et le centre du champ visuel est augmenté (magnification corticale)



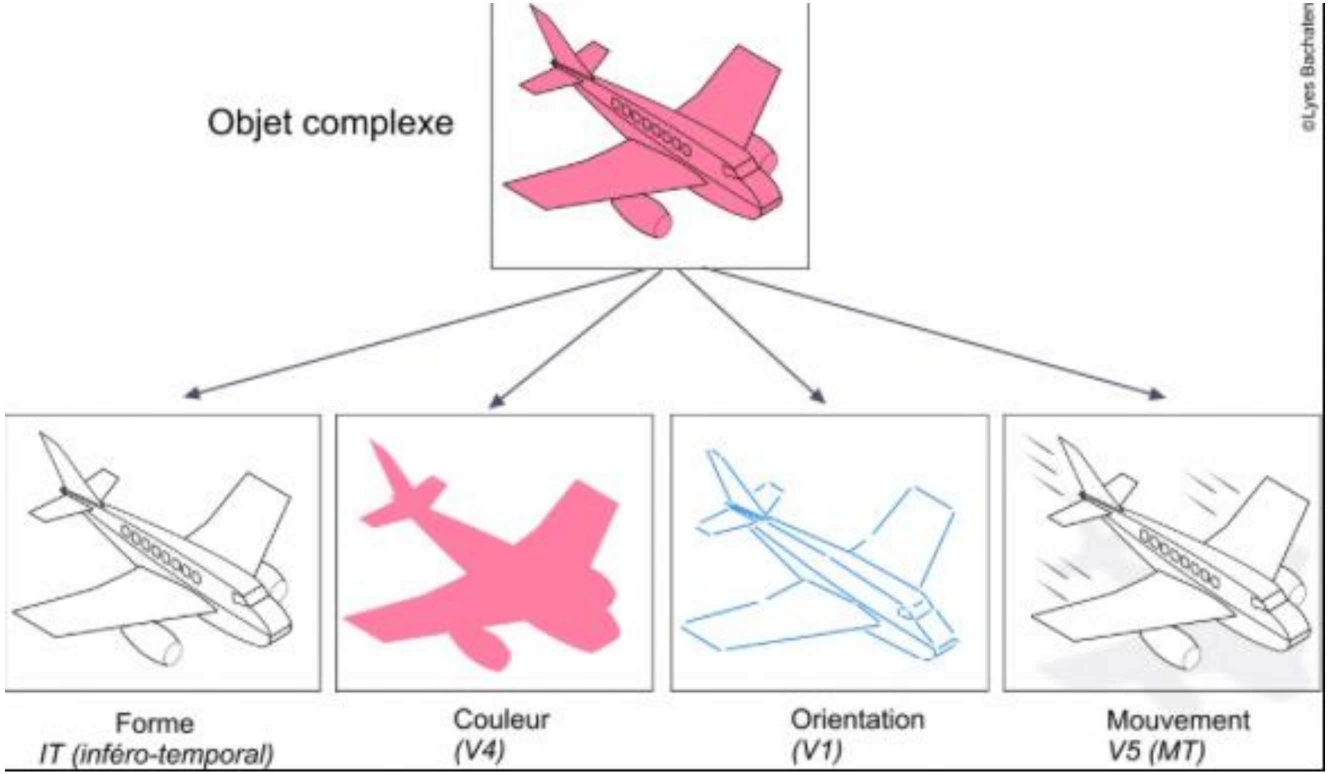
Ces schémas, établis dès 1918, représentent les territoires du cortex cérébral associés à différents secteurs du champ visuel gauche. De façon symétrique, le cortex occipital de l'hémisphère cérébral gauche est associé au champ visuel droit.



CORTEX VISUEL EXTRA-STRIÉ



Occipital médian: V2,V3 (bleu-mauve)
Occipital latéral: LO, MT (V5) (rouge-orange)
Occipital ventral: V4, VO (jaune-vert)
Postérior pariétal cortex: IPS (brun)



VOIE DORSALE ET VOIE VENTRALE

Voie dorsale: « where »-où se trouve ce que je vois; perception du mouvement, relations spatiales, intégration visuo-motrice

Voie ventrale: « What »-Que vois-je ? Reconnaissance et identification des objets, des formes des couleurs, des visages, etc.

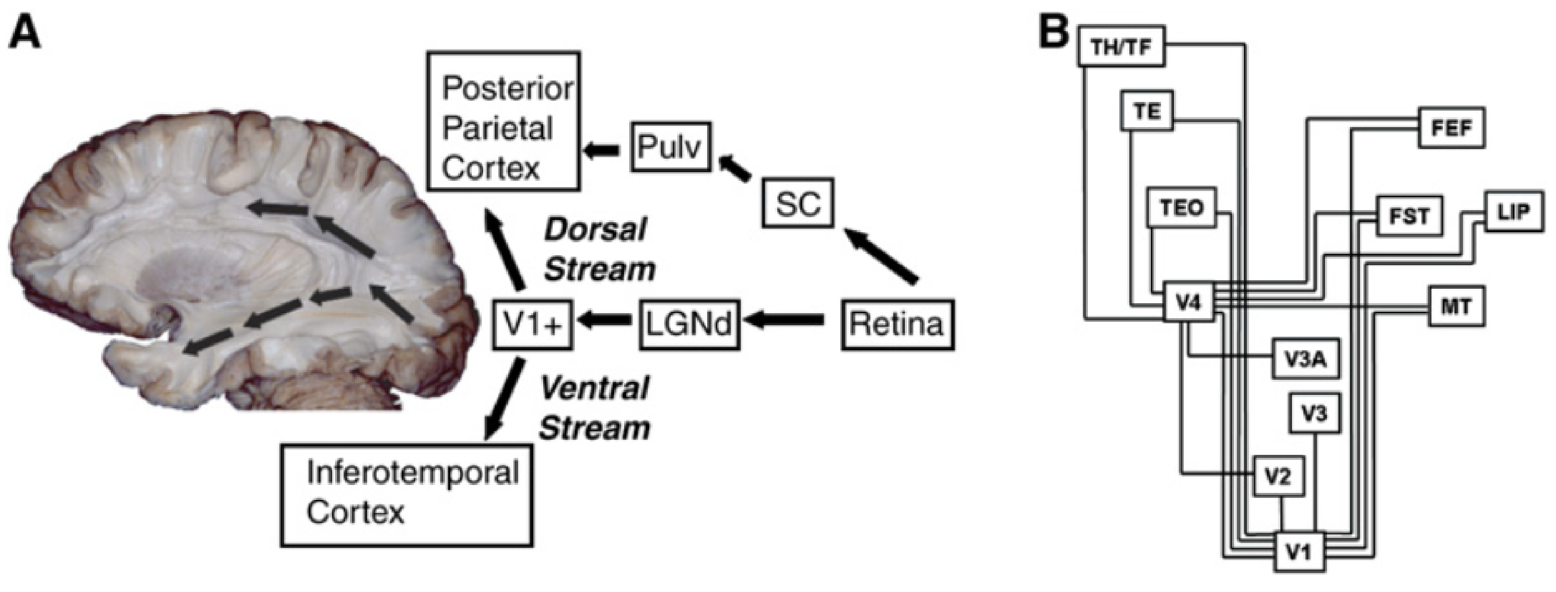
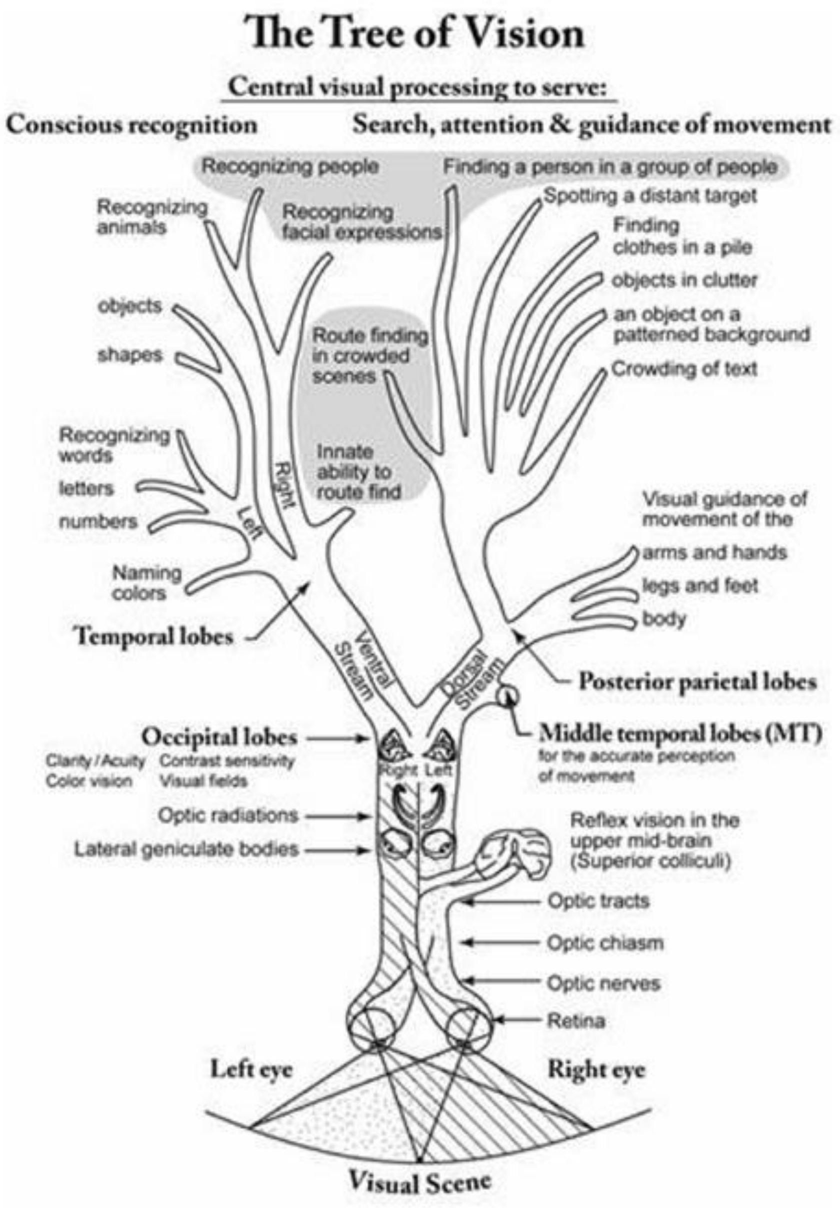


Figure 8. Theories of Visual Field Map Organization

(A) Signals in V1 and nearby maps are essential for vision; damage to these maps causes a visual blindspot (scotoma). Ungerleider and Mishkin (1982) suggest that visual signals enter two large white matter tracts (the superior and inferior longitudinal fasciculus) that are specialized for distinct visual functions. Damage in the projection zones of these tracts does not cause complete blindness but rather specific and dissociable performance deficits. Signals along the superior path appear to be specialized for action or spatial orientation; signals along the inferior path appear to be specialized for object recognition (Milner and Goodale, 2006; Ungerleider and Mishkin, 1982). (Brain image courtesy of Dr. Ugur Ture.)

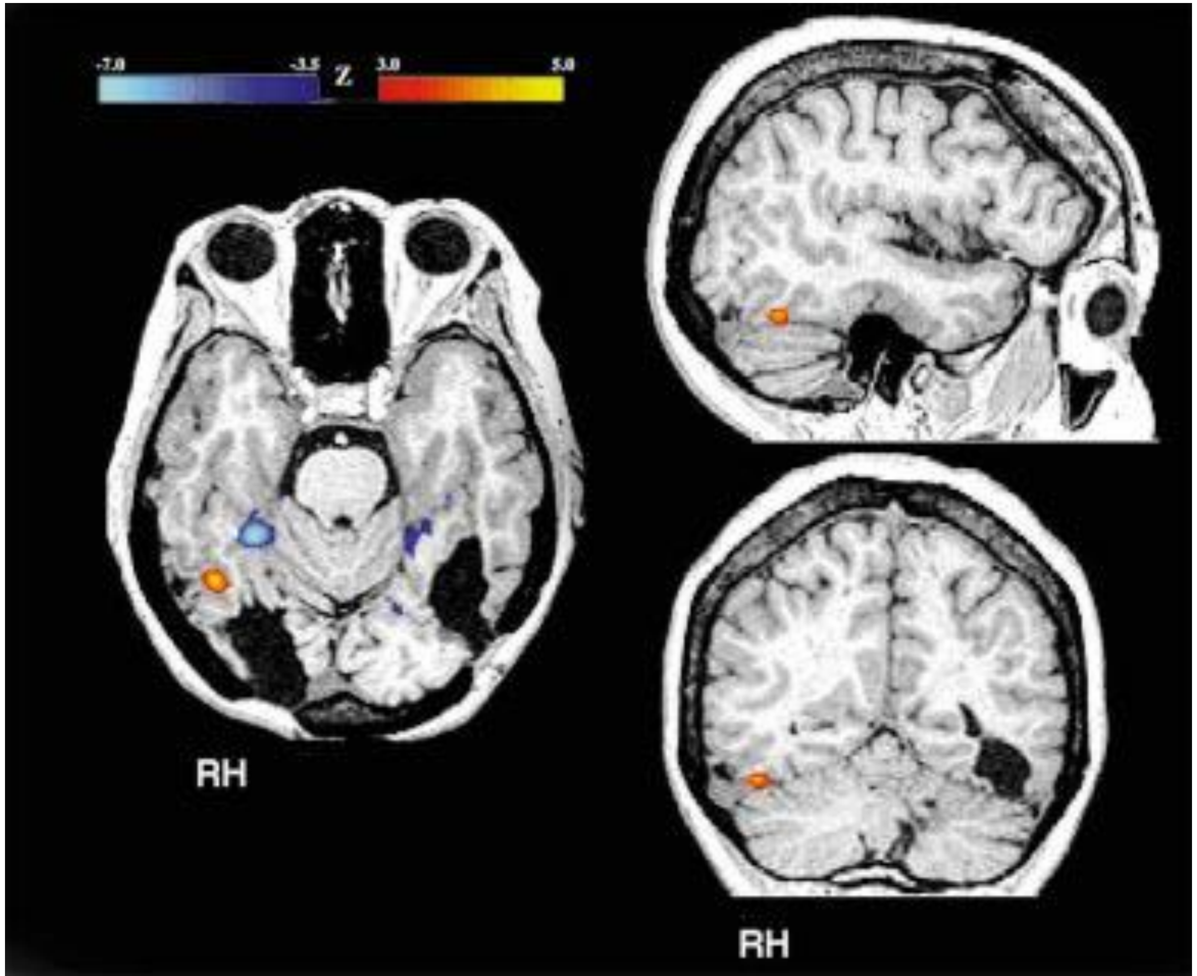
(B) Signals between visual field maps are carried along pathways whose axons terminate in distinct patterns. These termination patterns are classified into ascending, descending, and lateral connectivity and establish a hierarchical representation (Felleman and Van Essen, 1991; Van Essen and Maunsell, 1983). A simplified version of the hierarchy, showing the relationship between a subset of the maps in macaque, is shown here. This figure is from Figure 11 in Barone et al. (2000).

L'ARBRE DE LA VUE



EXEMPLE: PROSOPAGNOSIE

Voie ventrale: « What »-Que vois-je ? Reconnaissance et identification des objets, des formes des couleurs, des visages, etc.

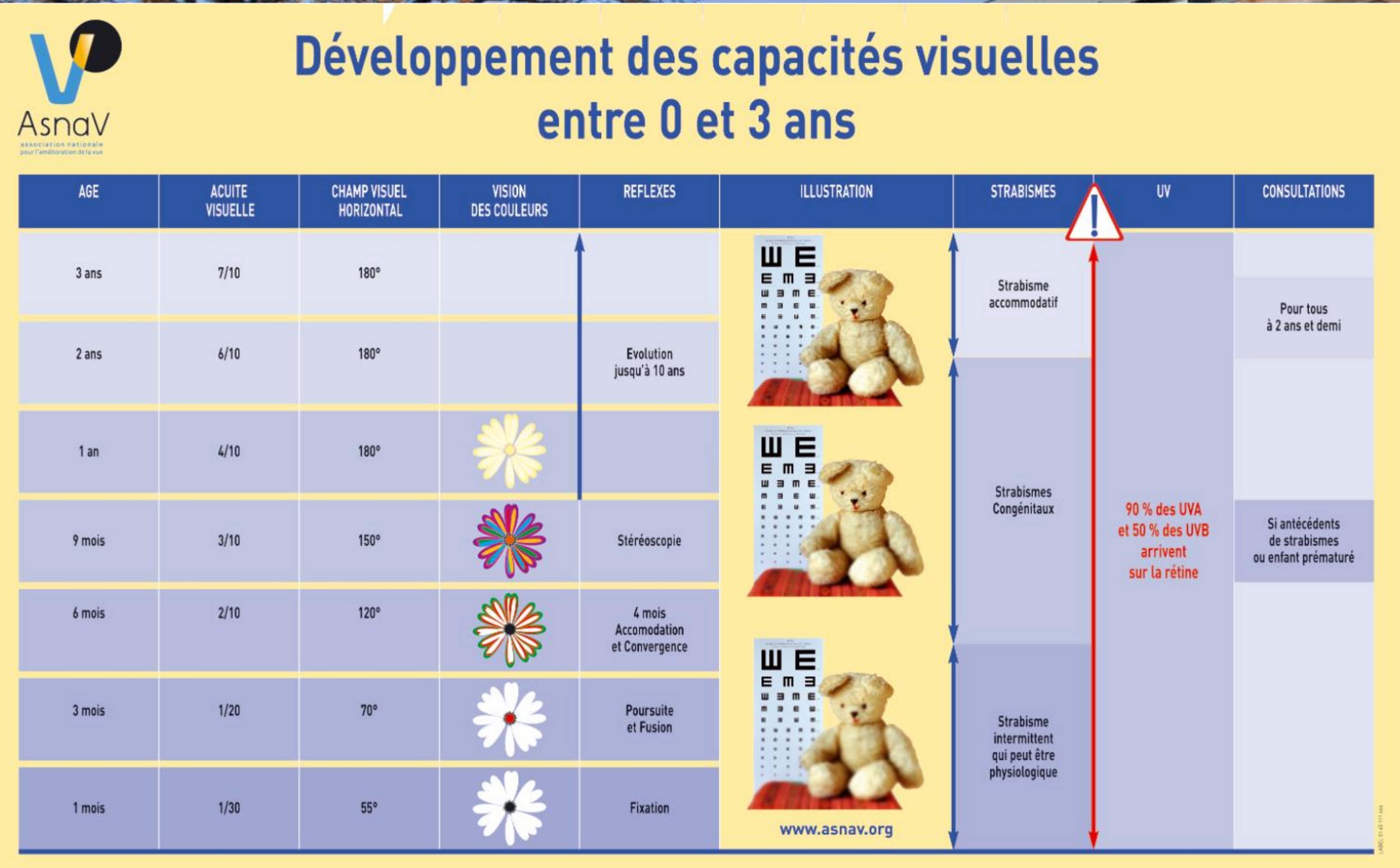


Patient P.S.

P.S. is a 52-year-old woman (born in 1950; right-handed) who sustained a closed head injury (hit at the back of the head by a bus) in 1992. CT scans first indicated contusions in the occipital and parieto-occipital regions, and the left cerebellum. A recent MRI scan revealed lesions to the lateral part of the occipital and temporal lobes, bilaterally, as well as in the anterior part of the left cerebellum. The right hemisphere lesion extends from the posterior part of the inferior occipital gyrus to the posterior fusiform gyrus. The left hemisphere region is more anterior and covers a large part of the fusiform gyrus, extending into the lower part of the temporal lobe (Fig. 1).

et al., 1999). P.S. complains of a profound difficulty in recognizing faces, including those of her own family, and her own face. To determine a person's identity, P.S. is reliant on cues such as haircut, hat, moustache or earrings, but also on the person's voice, his/her posture and clothes. We presented

PARTICULARITÉ : DÉVELOPPEMENT DE LA VISION CHEZ L'ENFANT



AsnaV

Développement des capacités visuelles entre 0 et 3 ans

AGE	ACUITE VISUELLE	CHAMP VISUEL HORIZONTAL	VISION DES COULEURS	REFLEXES	ILLUSTRATION	STRABISMES	UV	CONSULTATIONS
3 ans	7/10	180°				Strabisme accommodatif		Pour tous à 2 ans et demi
2 ans	6/10	180°		Evolution jusqu'à 10 ans				
1 an	4/10	180°				Strabismes Congénitaux		
9 mois	3/10	150°		Stéréoscopie			90 % des UVA et 50 % des UVB arrivent sur la rétine	Si antécédents de strabismes ou enfant prématuré
6 mois	2/10	120°		4 mois Accomodation et Convergence				
3 mois	1/20	70°		Poursuite et Fusion		Strabisme intermittent qui peut être physiologique		
1 mois	1/30	55°		Fixation				

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Métabolisme glucose entre naissance et 3 mois

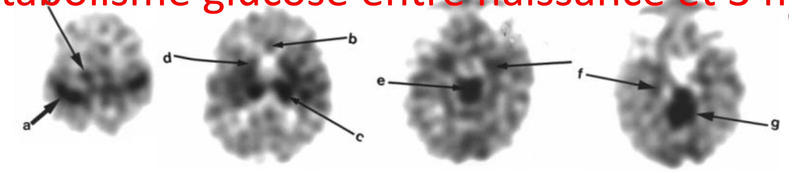
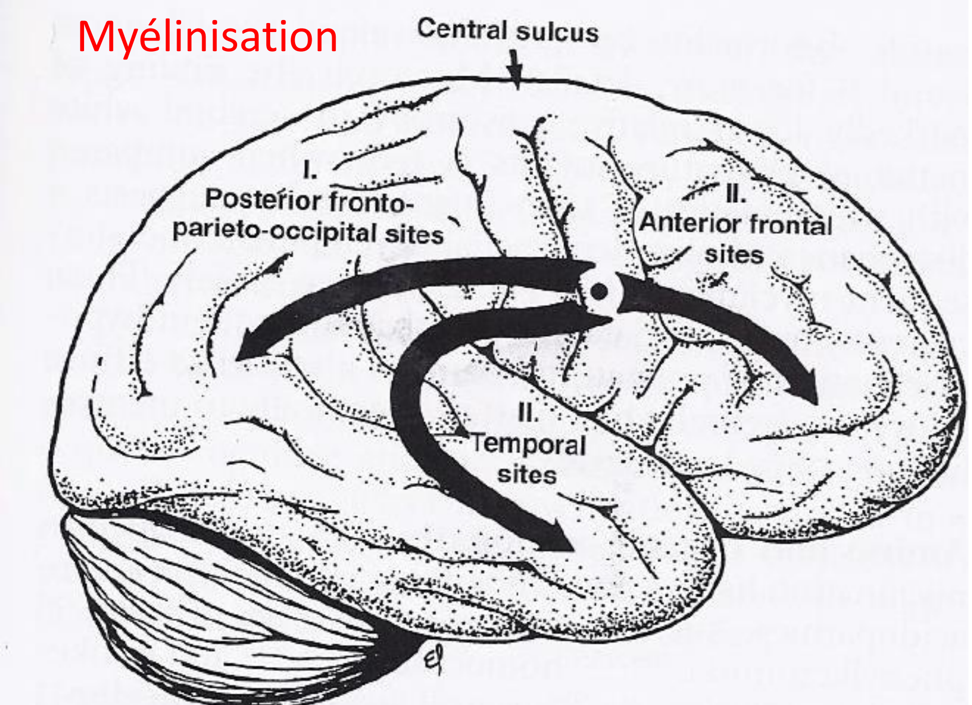


FIG. 1. Newborn pattern of cerebral glucose metabolism. At this stage of development, glucose metabolism is most apparent in sensorimotor cortex (a), cingulate cortex (b), thalamus (c), basal ganglia (d), brain stem (e), mesial temporal region (f), and cerebellar vermis (g). Metabolic activity is low in most of the frontal, parietal, temporal, and occipital cortex, as well as in the cerebellar cortex.

FIG. 2. Pattern of cerebral glucose metabolism in a 3-month-old infant. Glucose metabolism has increased in parietal cortex (a), occipital cortex (b), temporal cortex (c), basal ganglia (d), and cerebellar hemispheres (e). Metabolic activity in frontal cortex remains low (f).

Myélinisation



0-3 mois: noir et blanc
4-5 mois: rouge
6-7 mois: vert
8 mois: les couleurs vives
9 mois: vision totale de toutes les autres couleurs pastel

Visual Fixation in Human Newborns Correlates with Extensive White Matter Networks and Predicts Long-Term Neurocognitive Development

Infants are well known to seek eye contact, and they prefer to fixate on developmentally meaningful objects, such as the human face. It is also known, that visual abilities are important for the developmental cascades of cognition from later infancy to childhood. It is less understood, however, whether newborn visual abilities relate to later cognitive development, and whether newborn ability for visual fixation can be assigned to early microstructural maturation. Here, we investigate relationship between newborn visual fixation (VF) and gaze behavior (GB) to performance in visuomotor and visual reasoning tasks in two cohorts with cognitive follow-up at 2 ($n = 57$) and 5 ($n = 1410$) years of age. We also analyzed brain microstructural correlates to VF ($n = 45$) by voxel-based analysis of fractional anisotropy (FA) in newborn diffusion tensor imaging. Our results show that newborn VF is significantly related to visual-motor performance at both 2 and 5 years, as well as to visual reasoning at 5 years of age. Moreover, good newborn VF relates to widely increased FA levels across the white matter. Comparison to motor performance indicated that early VF is preferentially related to visuocognitive development, and that early motor performance relates neither to white matter integrity nor to visuocognitive development. The present findings suggest that newborn VF is supported by brainwide subcortical networks and it represents an early building block for the developmental cascades of cognition.

Key words: attention;

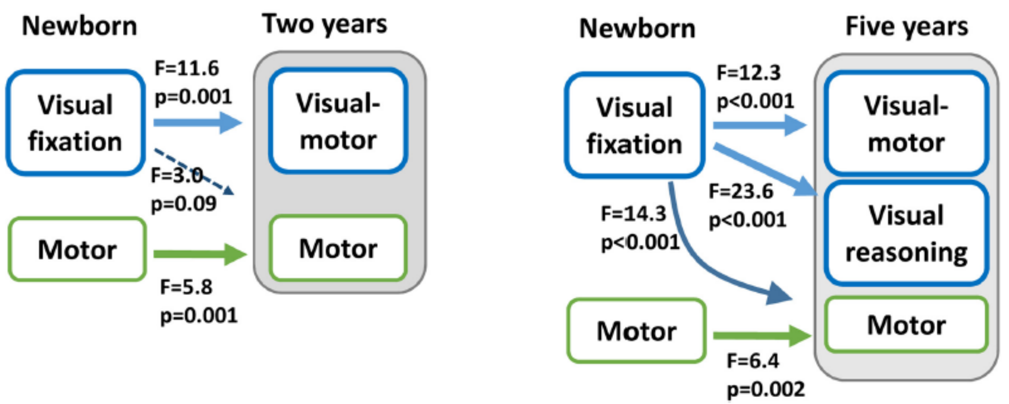


Figure 1. Relation of newborn VF and GB to neurocognitive outcomes at 2 and 5 years. ***A***, Gvmi at 2 years (Group 1) according to newborn VF and GB scores (mean ± confidence interval 95%). ***Ab***, ***Ad***, Findings from categorical regression analysis (Q, quantifications; estimated ± 95% confidence intervals). Q, Quantifications of Gvmi. ***B***, ViR and VMI at 5 years (Group 2) according to newborn VF scores. ***C***, Models combining visual and motor performance (left, Group 1; right, Group 2) show the preferential relationship from newborn VF to visual cognitive outcomes. DQ, Developmental quotient. Significant findings are indicated with an asterisk.

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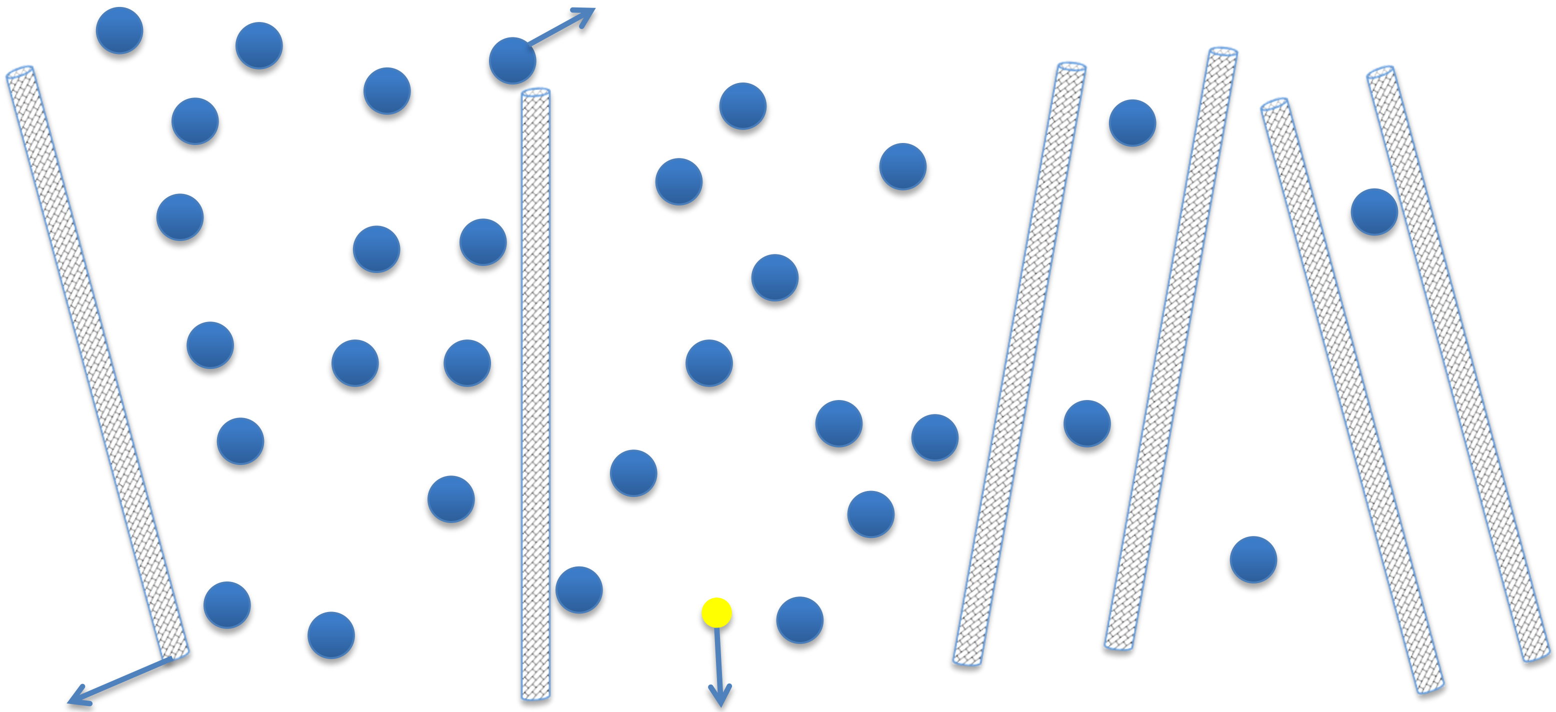
How ?

- DTI (diffusion tensor imaging)



Visual Fixation in Human Newborns Correlates with Extensive White Matter Networks and Predicts Long-Term Neurocognitive Development

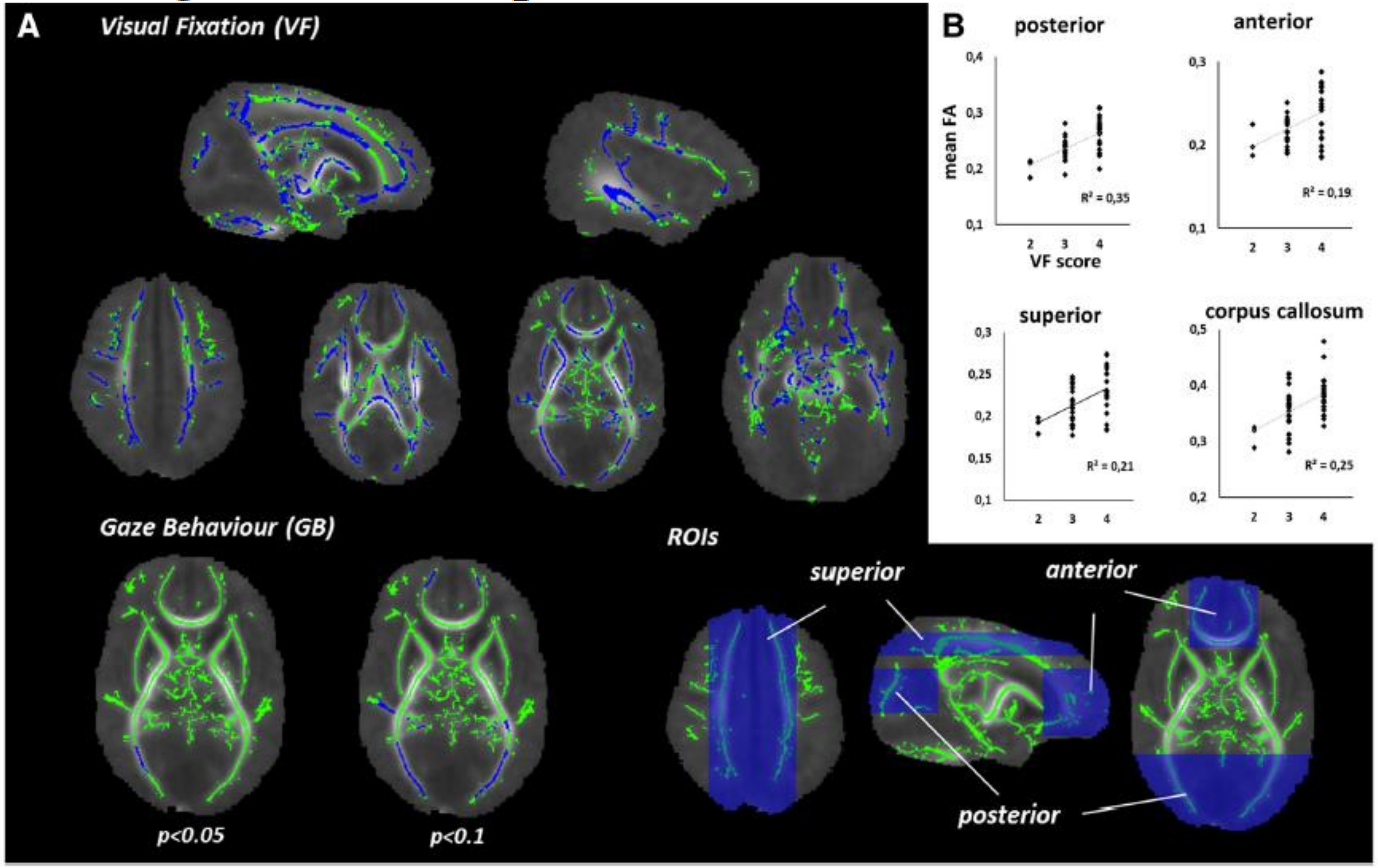
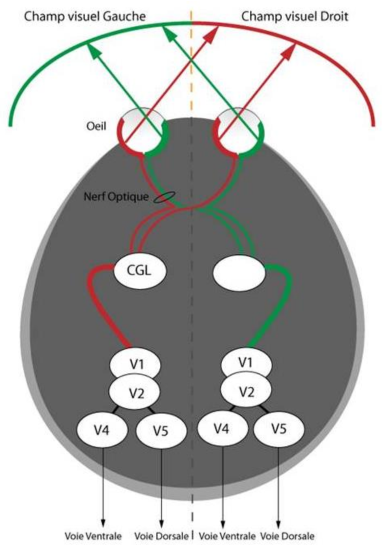


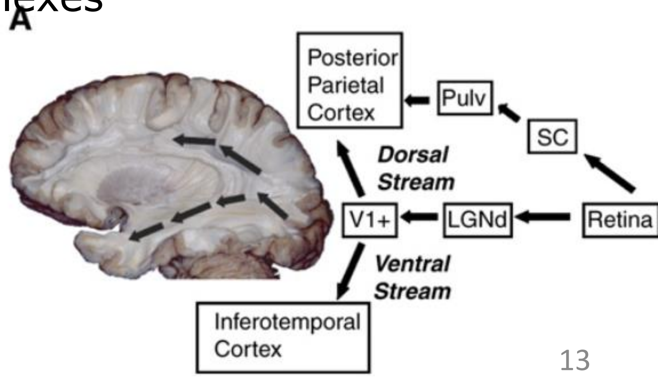
Figure 2. Structural correlates of newborn VF and GB. ***A***, White matter skeleton is depicted in green, and voxels with significant correlation to VF (top) or GB (bottom) are depicted in blue. ***B***, Mean FA values of FA skeleton voxels within each region of interest (ROI, blue boxes).

TROUBLES NEUROVISUELS

- Définition: difficulté particulière à explorer, analyser, mémoriser, visuellement ou à orienter son attention dans l'espace.



- Deux groupes
  - Troubles de la vision élémentaire
    - Atteinte de bandelettes optiques, CGL, radiations optiques, V1
      - Cécité (portion) champ visuel, selon l'étendue de la lésion
        - » Cécité corticale jusqu'au scotome, en passant par la vision tubulaire, périphérique, Hémianopsie, quadranopsie: peuvent aussi se présenter de manière successive chez un même patient
  - Troubles de la cognition visuelle
    - Atteintes voies dorsales et/ou des voies ventrales donnent des troubles plus complexes
      - Attention visuelle
      - Exploration visuelle
      - Organisation
      - Représentation de l'espace
      - Reconnaissance visuelle
      - Coordination visuo-motrice



TROUBLES NEUROVISUELS

- Populations à risque

1. La naissance prématurée (<37 semaines âge gestationnel) en particulier < 32 semaines (35%)

– Leucomalacie périventriculaire (LMPV) (B)

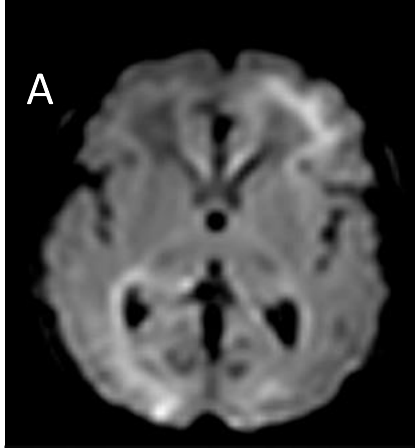
  - Susceptibilité des cellules gliales immatures (pré-oligodendrocytes) à l'ischémie et l'infection
  - Touche essentiellement les régions cérébrales postérieures
    - » Radiations optiques (vision élémentaire)
    - » Régions pariétales postérieures (cognition visuelle)

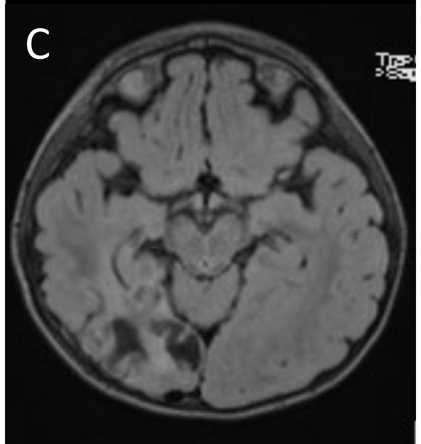
2. L'asphyxie à terme (A)

  - Atteinte cortex strié, de la substance blanche, ganglions de la Base, thalamus et tronc cérébral impliquant les noyaux oculomoteurs
  - Souvent des troubles moteurs et cognitifs associés
    - Examen visuel et neurovisuel difficile à réaliser

3. Autre

  - Hypoglycémie, infections SNC (C) , malformations cérébrales, anomalies chromosomiques, pas d'étiologie évidente, etc.

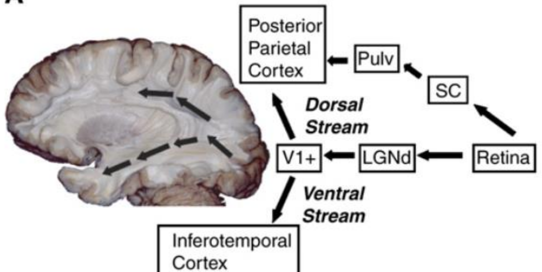


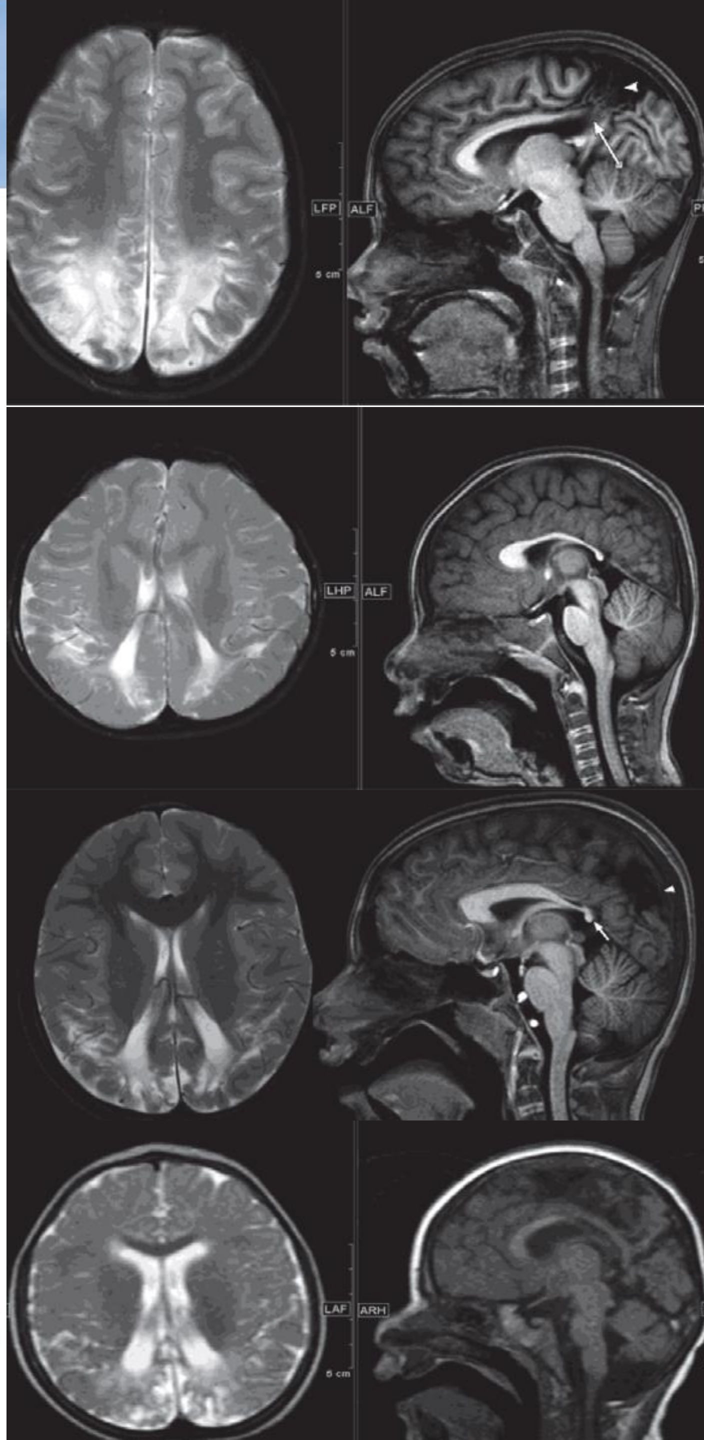


COGNITION VISUELLE

- Attention et exploration visuelle (voie dorsale): syndrome de Balint
  - Paralysie psychique du regard (incapacité à déplacer volontairement le regard)
  - Simultagnosie (difficulté à reconnaître les objets lorsqu’ils sont présentés simultanément)
  - Ataxie optique (difficultés à diriger des actes volontaires sous le contrôle de la vision)
- Syndrome de Balint pédiatrique (Philip at al., 2016)
  - Maladroits, difficultés pour lire et recopier des textes, difficultés scolaires, difficultés à monter les escaliers, à marcher sur des sols inconnus sans tomber, ataxie optique avec impossibilité de placer correctement des objets en bord de table, environnement surchargé angoisses+++, trouver des objets dans un environnement visuel surchargé est insurmontable, difficultés pour s’habiller

A





BALINT CASE REPORT

TABLE 1: Profiles of children with features of Balint's syndrome.

	Case 1	Case 2	Case 3	Case 4	Case 5
Age at presentation to the clinic	8 years	4 years	7 years	11 years	7 years
Gender	Male	Male	Male	Male	Female
Gestational age	32 weeks	40 weeks	36 weeks	32 weeks	36 weeks
Birth weight	1.2 kg	2.5 kg	1.8 kg	2.25 kg	2.0 kg
Antenatal complications	Pregnancy induced hypertension (PIH)	Nil	Nil	Nil	Nil
Effect of visual disability	Poor performance at school	Clumsiness	Poor performance at school	Poor performance at school	Poor performance at school
Visual acuity	6/60	6/48	6/24	6/6	6/24
Fundus	Normal	Normal	Normal	Normal	Normal
Simultanagnostic visual dysfunction	Present	Present	Present	Present	Present
Optic ataxia	Present	Present	Present	Present	Present
Apraxia of gaze	Present	Present	Present	Present	Present
Problems with clutter, crowd, and lower field defect	Present	Present	Present	Present	Present
Difficulties recognizing faces, words, shapes, and objects	Present	Present	Present	Present	Present
Radiological findings	Biparietooccipital gliosis + corpus callosum thinning	Biparietooccipital gliosis + corpus callosum thinning	Bilateral occipital gliosis + corpus callosum thinning	Biparietal gliosis + corpus callosum thinning	Mild posterior parietooccipital gliosis

- Attention et exploration visuelle (voie dorsale): Hémi-inattention et héminégligence spatiale
  - Atteinte pariétale postérieure unilatérlae
  - Plus sévère lorsque atteinte est à droite
  - Marqué par une difficulté à interagir avec un stimuli présenté du côté contralatéral à la lésion

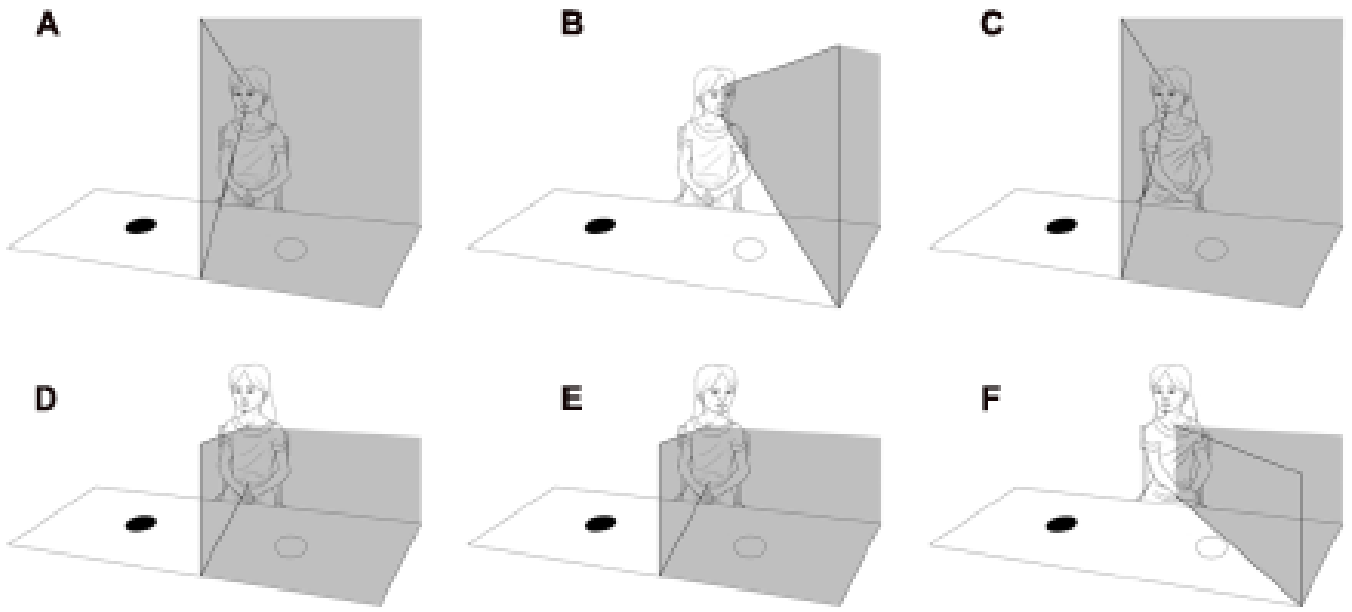
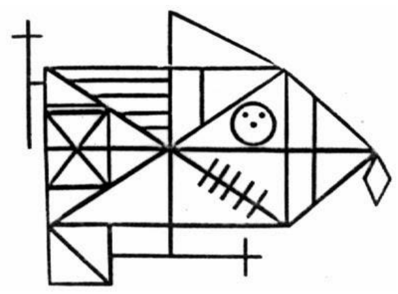
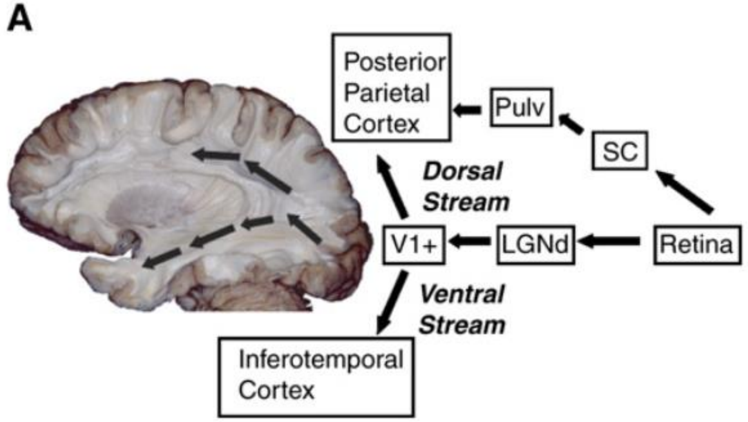


FIGURE 4 | Diagram illustrating the difference between hemianopia and visual neglect. (A) Illustrates left hemianopia due to right occipital lobe damage that moves with rotation of the head and eyes **(B)**, but not rotation of the body **(C)**. **(D)** Illustrates left visual neglect due to damage of the right inferior posterior parietal lobe, that does not move with rotation of the head and eyes **(E)**, but does move with rotation of the body **(F)**.

- Troubles de l'organisation et de la représentation de l'espace
  - Evalués au travers
    - tâches de production et copie figure géométrique





    - Agencement de cubes, de puzzles et de tâches d'imagerie mentale
  - Trouble de la reconnaissance visuelle (agnosie visuelle)
    - Atteinte région occipito-temporale (voie ventrale)
    - Reconnaissance objet visuel impossible, possible via autre modalité sensorielle (ex toucher)
      - » Images, objets, visages et matériel orthographique

- Troubles de la coordination visuo-motrice
  - Altération de la vision qui ne permet pas de correctement ajuster le geste
  - Performances motrices se dégradent lorsque la vision intervient, s ’améliorent lorsque l’entrée visuelle est supprimée
    - Dyspraxie visuo-spatiale

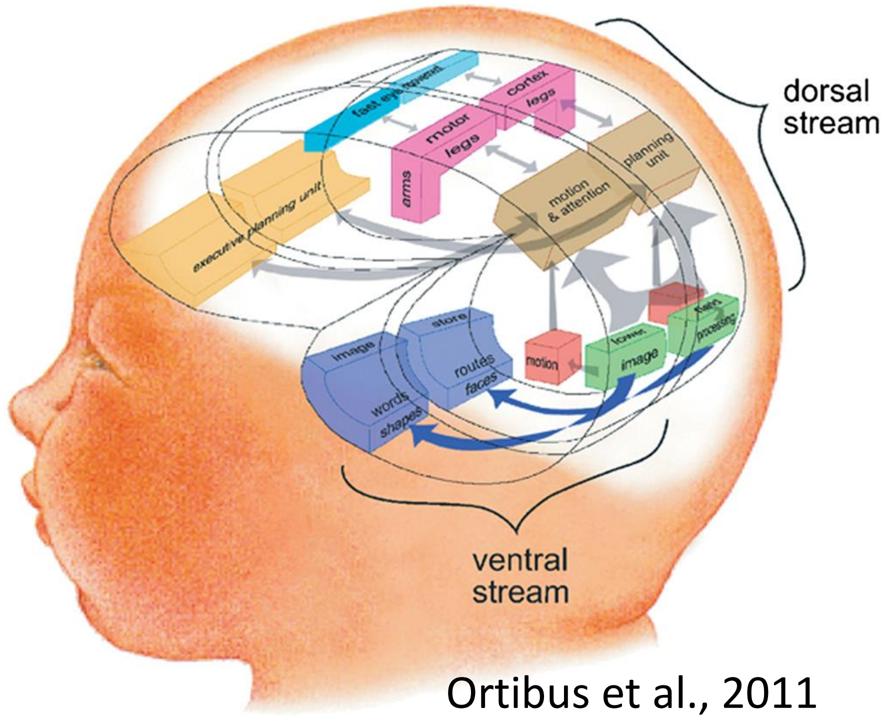
Table 1. Clinical features of cerebral visual impairment*

Ventral Stream Impairment
- Impaired recognition of faces, objects, shapes, letters, or gestalt
- Impaired visual memory
- Impaired orientation

Dorsal Stream Impairment
- Impaired ability to handle complex scenes in two-dimensional and three-dimensional space
- Impaired visual search
- Impaired visually guided movement of upper and lower limbs
- Impaired visual attention
- Impaired perception of motion

Additional Ophthalmologic Cues
- Unilateral or bilateral lower visual field loss
- Loss of acuity

* Children typically present with a complex combination of these features.



Ortibus et al., 2011

TROUBLES NEUROVISUELS

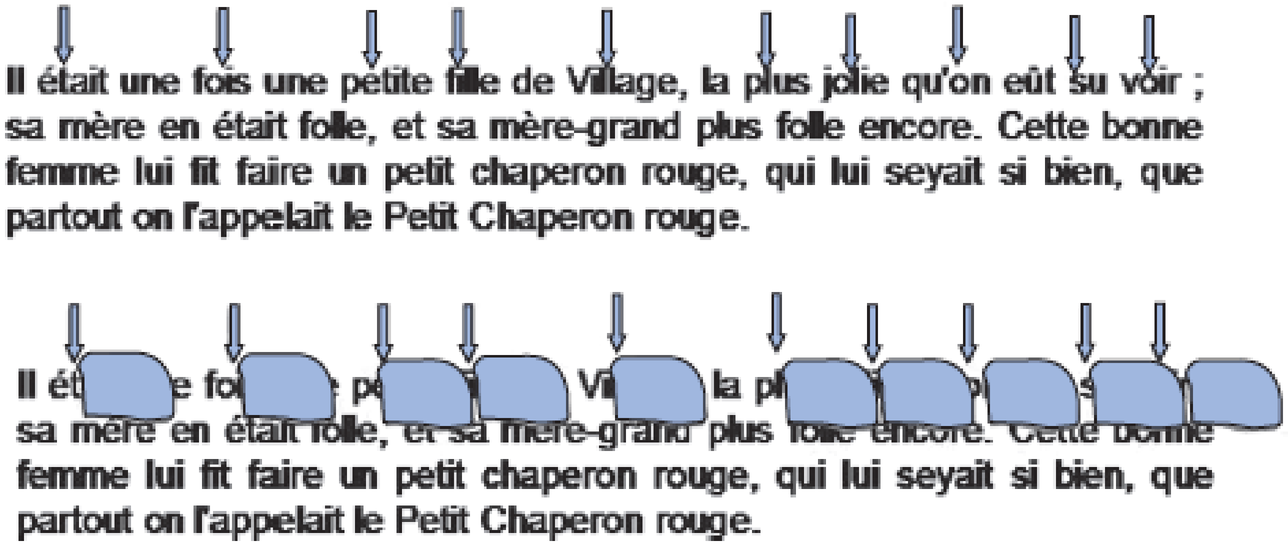
- 5% des enfants scolarisés présentent troubles des apprentissages

- Vision= socle des apprentissages (Mazeau et al, 2005)
  - Troubles neurovisuels peut-être à l'origine d'un ou des troubles d'apprentissage

    - Cas particuliers des enfants
      - Difficultés d'évaluation et de diagnostic, diagnostic tardif avec impact majeur sur les apprentissages
      - Congénital, doivent construire et développer toutes leurs habilités cognitives avec ce handicap
      - Pas de plaintes car pas de comparaison avec système intègre antérieur

TROUBLES NEUROVISUELS ET TROUBLES DES APPRENTISSAGES

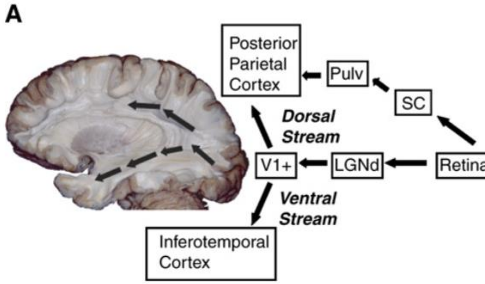
- La lecture nécessite
  - Bonne vision fovéale mais aussi informations visuelles périphériques (pour programmer le déplacement des yeux sur le mot suivant)
    - Exemple: hémianopsie latérale homonyme droite, flèches=saccades



  - Bonne capacités d'attention visuelle: simultagnosie ou négligence spatiale unilatérale peuvent également perturber la lecture
  - Reconnaissance orthographique (RO)
    - Trouble de la RO Peut s'observer après récupération d'une cécité corticale, ressemble à l'alexie de l'adulte

Chokron et al., 2015

- Dyslexie développementale
  - *« Specific learning disorder characterized by persistent difficulties in learning how to read accurately, fluently, and in reading comprehension caused by multiple genetic and environmental risk factors, as well as their interplay »*
  - On considère communément de manière simpliste que c'est un trouble phonologique
  - La lecture est un processus complexe dans lequel, en plus des compétences phonologiques interviennent également des compétences auditives, mnésiques, d'automatisation et visuo-spatiales. C'est la raison pour laquelle certains auteurs différencient la dyslexie phonologique de la dyslexie de surface et de la dyslexie mixte (la plus fréquente).



  - Développement de la lecture (voie dorsale sublexicale et ventrale lexicale)
    - Perception des différentes lettres et de leur correspondance phonétique
    - Reconnaissance des lettres et leur ordre dans l'espace
    - Associer un symbole avec un son, les mettre ensemble et déterminer une signification
      - Attention, conscience phonologique, mémoire verbale, analyse visuelle locale
    - Au fur et à mesure ou la lecture s'installe, l'analyse de lettres individuelle se transforme en la reconnaissance de mots par la vision et leur forme caractéristique
    - Evolue vers un processus automatique avec diminution importante de la charge cognitive de manière à ce que le lecteur possède des informations sémantiques et syntactiques lui permettant de faire des suppositions sur les mots à venir dans le texte et augmenter sa compréhension
      - Mémoire phonologique, reconnaissance de mots automatique, mémoire à long terme

The Role of Visual-Spatial Abilities in Dyslexia: Age Differences in Children's Reading?

Giulia Giovagnoli[1,2]*, Stefano Vicari*[1]*, Serena Tomassetti*[1] *and Deny Menghini*[1]*

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Reading is a highly complex process in which integrative neurocognitive functions are required. Visual-spatial abilities play a pivotal role because of the multi-faceted visual sensory processing involved in reading. Several studies show that children with developmental dyslexia (DD) fail to develop effective visual strategies and that some reading difficulties are linked to visual-spatial deficits. However, the relationship between visual-spatial skills and reading abilities is still a controversial issue. Crucially, the role that age plays has not been investigated in depth in this population, and it is still not clear if visual-spatial abilities differ across educational stages in DD. The aim of the present study was to investigate visual-spatial abilities in children with DD and in age-matched normal readers (NR) according to different educational stages: in children attending primary school and in children and adolescents attending secondary school. Moreover, in order to verify whether visual-spatial measures could predict reading performance, a regression analysis has been performed in younger and older children. The results showed that younger children with DD performed significantly worse than NR in a mental rotation task, a more-local visual-spatial task, a more-global visual-perceptual task and a visual-motor integration task. However, older children with DD showed deficits in the more-global visual-perceptual task, in a mental rotation task and in a visual attention task. In younger children, the regression analysis documented that reading abilities are predicted by the visual-motor integration task, while in older children only the more-global visual-perceptual task predicted reading performances. Present findings showed that visual-spatial deficits in children with DD were age-dependent and that visual-spatial abilities engaged in reading varied across different educational stages. In order to better understand their potential role in affecting reading, a comprehensive description and a multi-componential evaluation of visual-spatial abilities is needed with children with DD.

OPEN ACCESS

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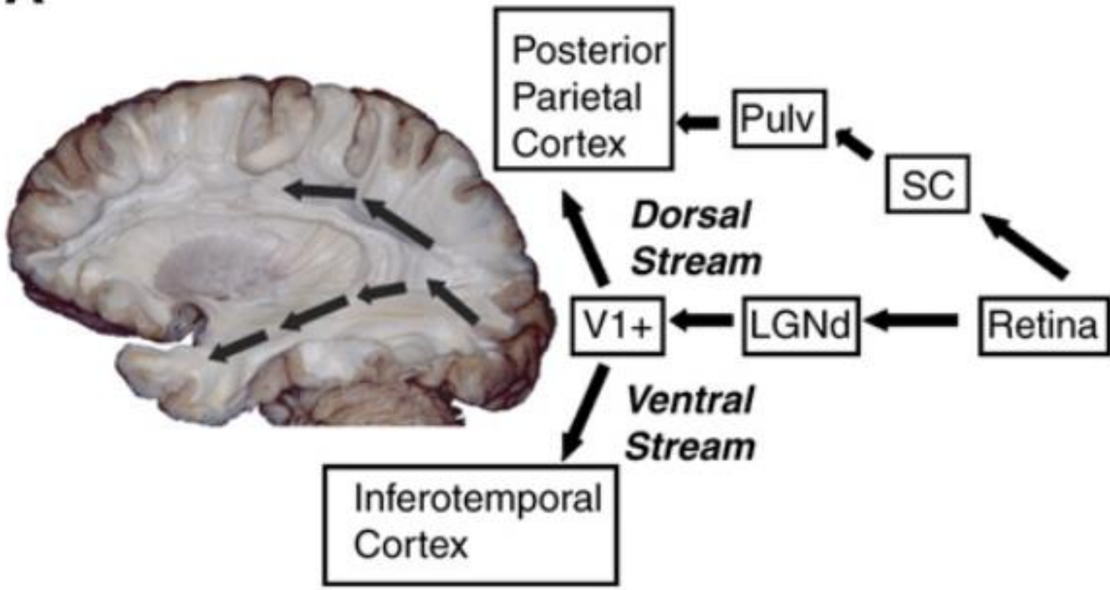
Specialty section:
This article was submitted to Developmental Psychology, a section of the journal Frontiers in Psychology

A



- Le calcul

  - Développement du calcul se réalise en trois étapes
    - Acquisition séquence verbale mot-nombre
    - Etablir un lien entre séquence verbale et quantité qu'elle représente
    - Acquisition du concept de relation entre les nombres
  - Dans ce modèle
    - MT visuo-spatiale
    - Représentation visuo-spatiale des nombres/quantités
  - Lien très fort entre visuo-spatial et calcul
    - Capacité à comparer 2 nombres (capacités visuo-spatiales) peuvent prédire les aptitudes logico-mathématiques, qui impliquent les aptitudes verbales de manière plus prononcée

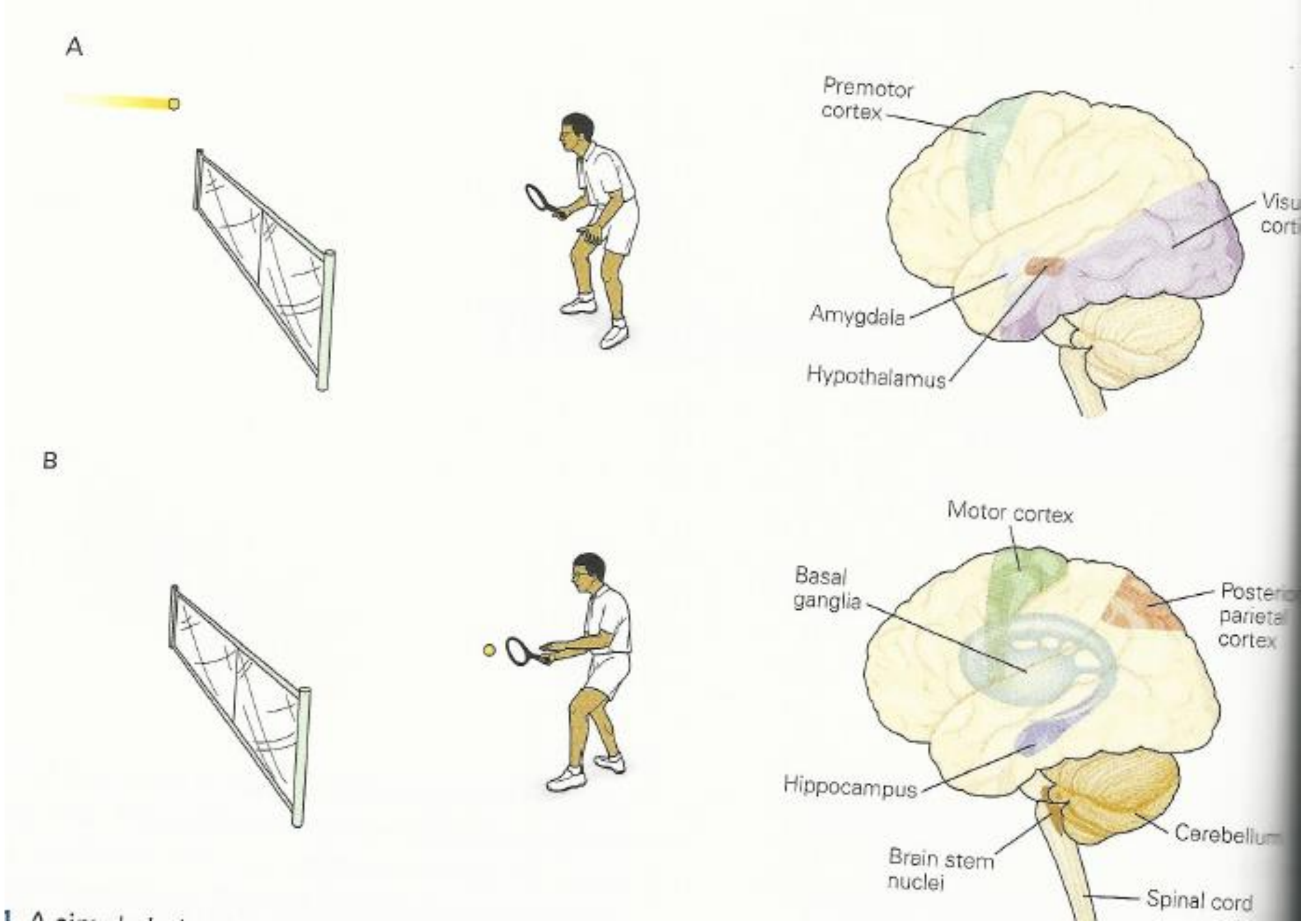
- Troubles neurovisuels

  - Ne vont altérer que certains aspects logicomathématiques (séquence verbale ok mais incapable de dire si 4 est plus grand que 3)

Chokron et al., 2015

- A. Joueur de tennis regarde arriver la balle en utilisant son cortex visuel pour juger de la taille, direction et vitesse de la balle. Le cortex premoteur développe un programme moteur pour renvoyer la balle.

- B. Pour exécuter le coup, le joueur doit utiliser toutes ces régions, ainsi que le cortex moteur qui envoie le signal à la moelle épinière pour activer et inhiber de nombreux muscles. Les noyaux de la base sont également impliqués pour initier des patterns de mouvement et rappeler des mouvements appris pour frapper correctement la balle. Le cervelet ajuste les mouvements sur base de données proprioceptives des récepteurs sensoriels périphériques. Le cortex pariétal postérieur donne au joueur l'information pour savoir ou son corps se situe dans l'espace et ou sa raquette est située par rapport à son corps.

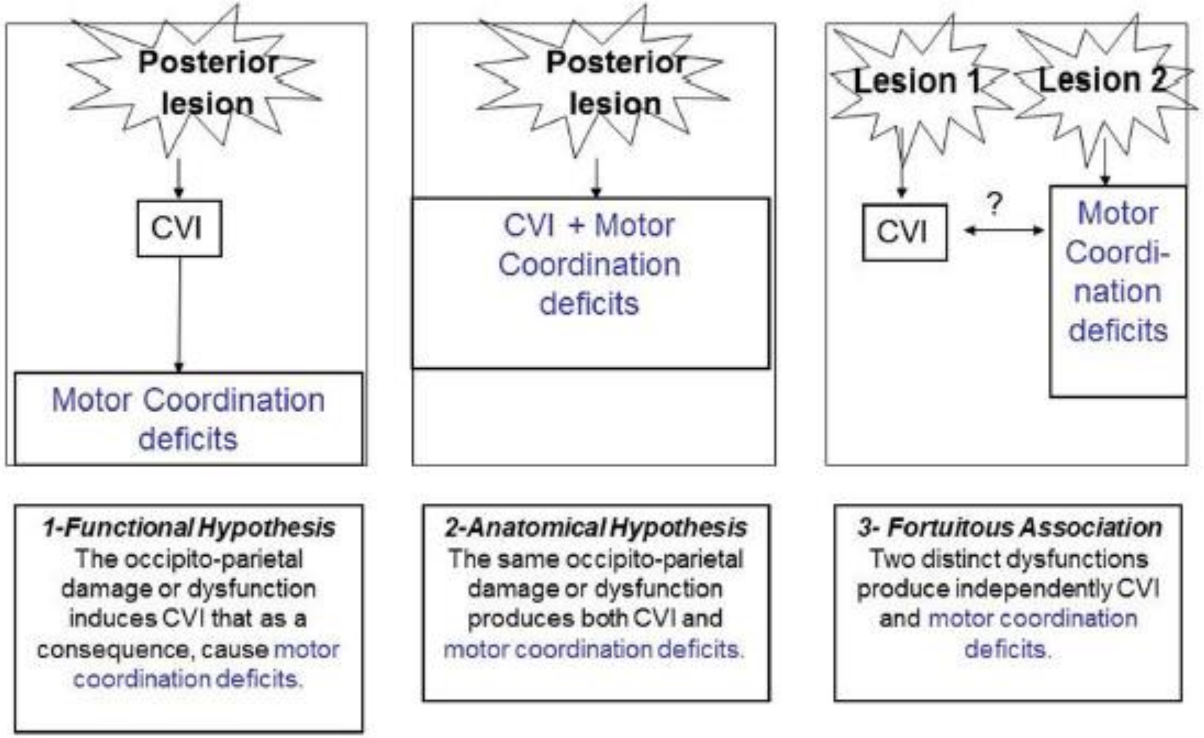


- TAC (DSM-V)
  1. Acquisition et exécution des activités motrices coordonnées sont significativement inférieures en regard des résultats attendus compte tenu de l'âge chronologique et du niveau intellectuel. Les difficultés se manifestent par maladresse (laisser tomber ou se cogner), de la **lenteur** et une faible performance dans la réalisation de certaines actions (pex attraper un objet, utiliser ciseaux ou un couteau, écrire, faire du vélo, faire un **spor**t)
  2. Existence d'une interférence significative avec les activités de la vie quotidienne (self care and self maintenance) et a un impact sur les performances scolaires de loisir et le jeux.
  3. Survenue des symptômes dans la période développementale précoce (Il peut y avoir un retard significatif dans l'acquisition des étapes du développement moteur (marcher, ramper, s'asseoir)
  4. Le déficit en performance motrice n'est pas mieux expliqué par une affection médicale générale (IMC, myopathie, etc), un retard mental ou un déficit visuel.
- Prévalence
  – 5-20% (5-6%)
  – H>F (2:1-7:1)
- Troubles ophtalmologiques présents dans 42% des cas (Bonheur et al., 2015)
  – 11% strabisme, 31% troubles de la réfraction

TROUBLES NEUROVISUELS ET TROUBLE D'ACQUISITION DE LA COORDINATION (DYSPRAXIE)

- TDAH
  - 50% des patients des TAC sont TDAH
  - TDAH +TAC ont un pronostic nettement moins bon que TDAH sans TAC
  - 87% ADHD ont des comorbidités
- Troubles du langage-apprentissages
  - Troubles de la lecture
    - Dyslexie non phonologique
      - Problèmes accès à la lecture de textes (programmation et organisation des mouvements de regards nécessaires à la lecture
  - Troubles de l'écriture
    - Lenteur et dysgraphie
  - Troubles langagiers et motricité BLF (20-30%)
    - Difficultés verbales expressives, bavage +++
  - Trouble du calcul
    - Dyscalculie secondaire aux pb d'accès aux facettes spatiales du nombre (dénombrement, numération arabe)

- Association fréquente troubles neurovisuels (TNV) et TAC
  - Difficile de diagnostiquer TAC si TNV
    - Tâches utilisées pour diagnostiquer TAC font appel aux modalités visuelles
    - Patients TNV sont à risque de présenter retard ou un déficit dans le contrôle moteur et postural, exécution motrice, coordination oculomotrice, orientation spatiale, reconnaissance visuelle et imagerie mentale comme les patients TAC
    - 3 types de liens entre TNV et TAC



e hypothetical links between CVI and motor coordination disorders.

Chokron et al., 2015

THE JOURNAL OF PEDIATRICS • www.jpeds.com ORIGINAL ARTICLES

Brain Connectomics of Visual-Motor Deficits in Children with Developmental Coordination Disorder

Julie Debrabant, MSc[1], Guy Vingerhoets, PhD[2], Hilde Van Waelvelde, PhD[1], Alexander Leemans, PhD[3], Tom Taymans, MSc[1], and Karen Caeyenberghs, PhD[1,4]

Research in Developmental Disabilities 34 (2013) 1478–1487

Contents lists available at SciVerse ScienceDirect

Research in Developmental Disabilities

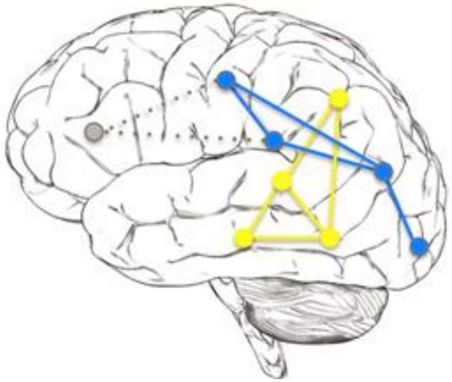
ELSEVIER

Neural underpinnings of impaired predictive motor timing in children with Developmental Coordination Disorder

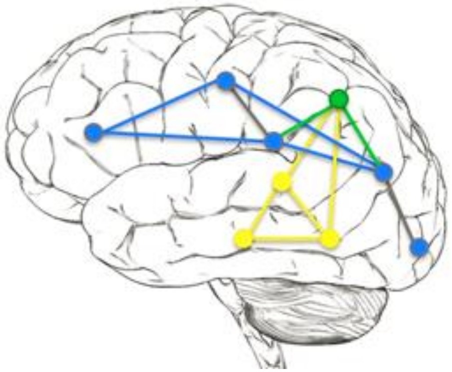
Julie Debrabant[a,*], Freja Gheysen[b], Karen Caeyenberghs[a,c], Hilde Van Waelvelde[a], Guy Vingerhoets[b]

MRI: DCD ⟷ CONTROLE

structural ≠



connectivity ≠



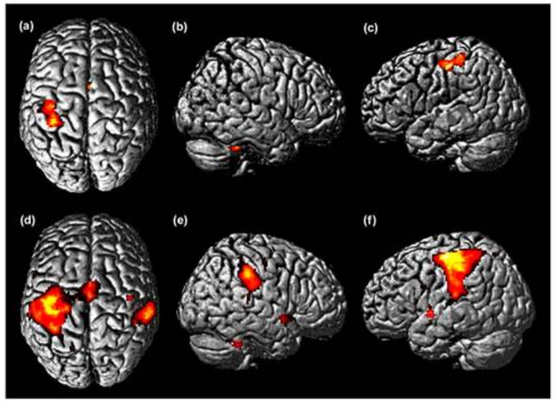


Figure 4.
(a), (b), and (c) are patterns of cortical activations on a rendered brain in 15 right-handed healthy subjects, and (d), (e), and (f) are patterns in 15 right-handed patients with SPMS during performance of a simple motor task with their clinically unimpaired and fully normal-functioning upper-right hands. Compared to controls, a larger and more significant activation of contralateral and ipsilateral primary sensori-motor cortex can be detected in SPMS patients.

TROUBLES NEUROVISUELS DEPISTAGE

- Batterie d'évaluation troubles visuo-attentionnels 4-6 ans
  - Champ visuel
  - Poursuite visuelle
  - Mémoire visuelle forme et de lettres
  - Attention visuelle sélective (barrages)
  - Figues enchevêtrées (simultagnosie)
  - Bissection de lignes
  - Histoire en images

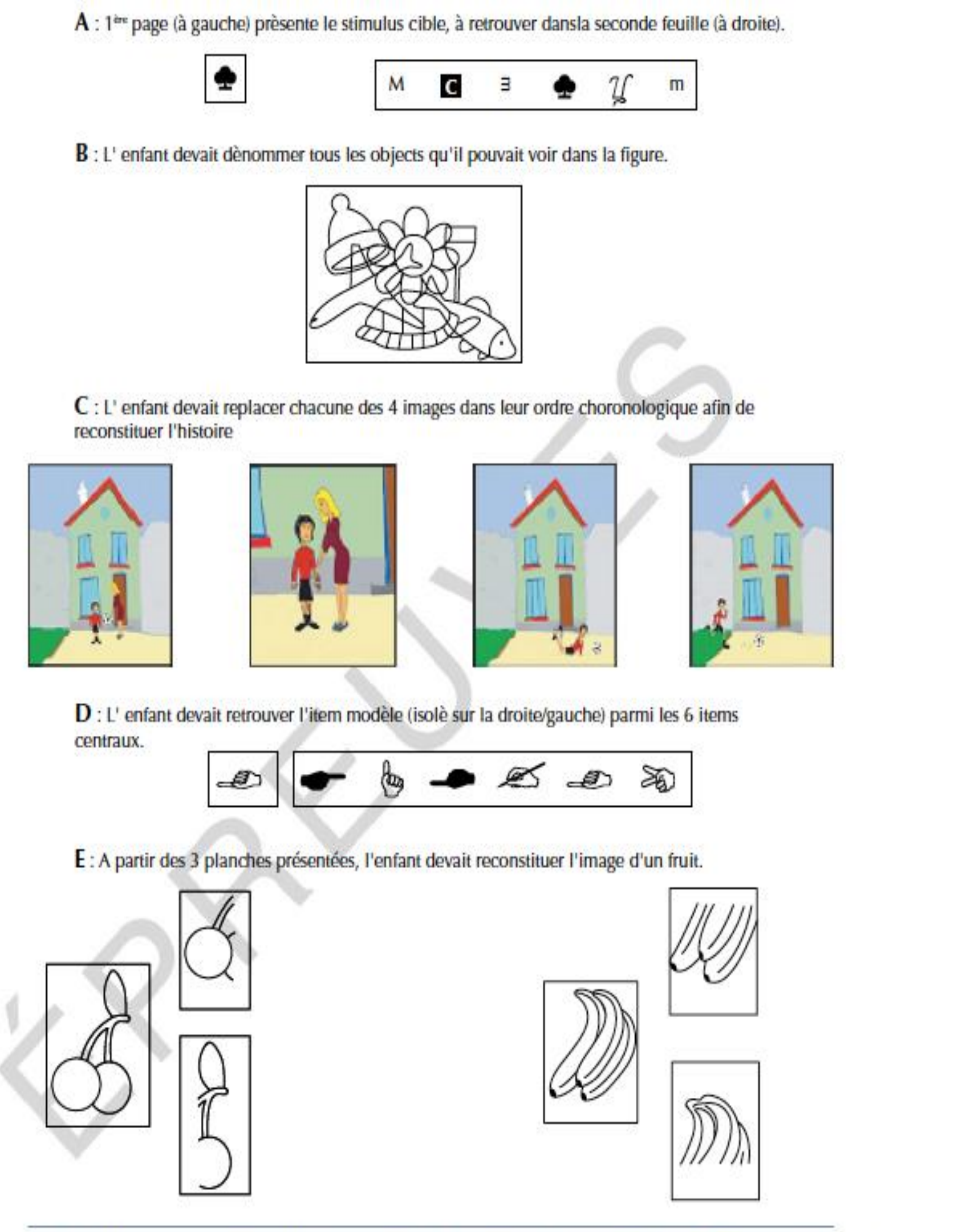


Figure 1. Exemple de stimuli utilisés dans les épreuves de mémoire visuelle des formes (A), de figures enchevêtrées (B), d'histoires en images (C), d'appariement de formes (D) et de puzzles de fruits (E).

Vilayponh et al., 2009

« Until then, rehabilitation programs will rely on trial and error. Indeed, some stimulation programs to encourage visual recovery were reported in the literature, but the results are difficult to interpret, in particular because every patient with cerebral visual impairment is different. In any case, stimulation programs should benefit from the growing understanding of mechanisms involved in the plasticity of the brain and of the effects of enriched environments. Ultimately, however, any individual rehabilitation program should be designed as a patient-tailored treatment »

Els Ortibus et al., 2011

- Etude rétrospective (1996-2003) sur 21 enfants avec TNV âgés de 26 à 126 mois
  - 20/21 épileptiques
  - Groupe contrôle ne recevant pas ce programme
  - Causes : PA ou LMPV
  - Programme de rééducation à domicile
  - Niveau visuel I, II ou III

Top down

Table 3. Visual levels used for Hoyt's retrospective study (Hoyt, 2003). These visual levels are comparable to the visual levels of the Developmental Profile employed in the present study

Visual level	Description
I	The child could only perceive light at the time of the examination
II	The patient could occasionally visually fixate on large objects, faces, or movement in the environment
III	If visual function as highly variable, but with at least some moments of good visual fixation as indicated by: (1) the ability to see small objects (such as coins or stickers) or (2) could reliably visually fixate a face
IV	If a patient could reliably fixate on small targets and/or with visual acuity that could be measured in the range of 6/36–6/60
V	If there was a good reliable fixation and/or with visual acuity (measured under binocular viewing conditions) of 6/18–6/36
VI	If there was a completely normal sensory visual examination

- Rééducation à domicile par les parents
  1. Réflexe à la lumière
     1. Flashlight, sur chaque œil, t=5s, chambre noire et calme, session de 1 minutes, répété 30 fois par jour
  2. Localiser la lumière
     1. Chambre noire, point munineux sur une cible, le patient doit détecter la cible, t=1 min 10 fois par jour
  3. Montrer des images objets noirs sur fond blanc (oiseau et araignée), 10 fois par jour
  4. Montrer un tableau avec carreaux noirs et blancs et ajouter plusieurs images dans les carreaux blancs et demander de les identifier
  5. Programme 3 en ajoutant des détails
  6. Montrer des mots écrits et essayer de les reconnaitre 10 fois par jour

- Résultats

Table 4. Summary of 20 case studies completing the visual stimulation program for CVI and the progress they made. This table contains information for each participant on pre-program level of function and the level that they had achieved at program termination, the age at the evaluations, the number of months it took for the child to achieve the post-treatment level, and how many levels each participant progressed

Patient's number	Highest level at IE	Highest level at RV	Age at IE*	Age at RV†	No. months for change	No. levels progressed
18	2	5	17	32	15	3
19	3	6	13	18	6	3
20	2	6	19	23	4	4

*IE = Initial evaluation.
†RV = Revisit evaluation.

Table 5. Control numbers and percentages of visual improvement (Hoyt, 2003)

	Striate cortex damage		Periventricular white matter damage		Total percentages	
Vision change	N	%	N	%	N	%
No improvement	9	21.9	15	57.6	24	36
Improved one level	18	43.9	8	30.7	26	38
Improved two levels	11	26.8	2	7.6	13	19
Improved three levels	2	4.8	1	3.8	3	4
Improved four levels	1	2.4	0	0	1	1.5
Improved five levels	0	0	0	0	0	0

TROUBLES NEUROVISUELS ET TROUBLES DES APPRENTISSAGES : FAUT-IL REEDUQUER LA VISION DANS LA DYSLEXIE?

American Academy of Pediatrics
DEDICATED TO THE HEALTH OF ALL CHILDREN™

Organizational Principles to Guide and Define the Child Health Care System and/or Improve the Health of all Children

Joint Technical Report—Learning Disabilities, Dyslexia, and Vision

abstract

FREE

Learning disabilities constitute a diverse group of disorders in which children who generally possess at least average intelligence have problems processing information or generating output. Their etiologies are multifactorial and reflect genetic influences and dysfunction of brain systems. Reading disability, or dyslexia, is the most common learning disability. It is a receptive language-based learning disability that is characterized by difficulties with decoding, fluent word recognition, rapid automatic naming, and/or reading-comprehension skills. These difficulties typically result from a deficit in the phonologic component of language that makes it difficult to use the alphabetic code to decode the written word. Early recognition and referral to qualified professionals for evidence-based evaluations and treatments are necessary to achieve the best possible outcome. Because dyslexia is a language-based disorder, treatment should be directed at this etiology. Remedial programs should include specific instruction in decoding, fluency training, vocabulary, and comprehension. Most programs include daily intensive individualized instruction that explicitly teaches phonemic awareness and the application of phonics. Vision problems can interfere with the process of reading, but children with dyslexia or related learning disabilities have the same visual function and ocular health as children without such conditions. Currently, there is inadequate scientific evidence to support the view that subtle eye or visual problems cause or increase the severity of learning disabilities. Because they are difficult for the public to understand and for educators to treat, learning disabilities have spawned a wide variety of scientifically unsupported vision-based diagnostic and treatment procedures. Scientific evidence does not support the claims that visual training, muscle exercises, ocular pursuit-and-tracking exercises, behavioral/perceptual vision therapy, "training" glasses, prisms, and colored lenses and filters are effective direct or indirect treatments for learning disabilities. There is no valid evidence that children who participate in vision therapy are more responsive to educational instruction than children who do not participate. *Pediatrics* 2011;127:e818–e856

Sheryl M. Handler, MD, Walter M. Fierson, MD, and the SECTION ON OPHTHALMOLOGY AND COUNCIL ON CHILDREN WITH DISABILITIES, AMERICAN ACADEMY OF OPHTHALMOLOGY AMERICAN ASSOCIATION FOR PEDIATRIC OPHTHALMOLOGY AN STRABISMUS, AND AMERICAN ASSOCIATION OF CERTIFIED ORTHOPTISTS

KEY WORDS
learning disabilities, vision, dyslexia, ophthalmology, eye examination, vision therapy

ABBREVIATIONS
ADHD—attention-deficit/hyperactivity disorder
IDEA—Individuals With Disabilities Education Act
ADA—Americans With Disabilities Act
IEP—individualized education plan
EBM—evidence-based medicine
SSS—scotopic sensitivity syndrome

The guidance in this report does not indicate an exclusive course treatment or serve as a standard of medical care. Variations, taki into account individual circumstances, may be appropriate.

This technical report supports the joint policy statement from the American Academy of Pediatrics, American Academy of Ophthalmology, American Academy of Pediatric Ophthalmology an Strabismus, and American Association of Certified Orthoptists titl "Learning Disabilities, Dyslexia, and Vision," which is available at www.aap.org (direct link: www.aappolicy.org/cgi/reprint/pediatri 124/2/837.pdf) and www.aao.org (direct link: www.aao.org/about/policy/upload/Learning-Disabilities-Dyslexia-Vision-2009.pdf).

All technical reports from the American Academy of Pediatrics automatically expire 5 years after publication unless reaffirmed, revised, or retired at or before that time.

Top Down

function and ocular health as children without such conditions. Currently, there is inadequate scientific evidence to support the view that subtle eye or visual problems cause or increase the severity of learning disabilities. Because they are difficult for the public to understand and for educators to treat, learning disabilities have spawned a wide variety of scientifically unsupported vision-based diagnostic and treatment procedures. Scientific evidence does not support the claims that visual training, muscle exercises, ocular pursuit-and-tracking exercises, behavioral/perceptual vision therapy, "training" glasses, prisms, and colored lenses and filters are effective direct or indirect treatments for learning disabilities. There is no valid evidence that children who participate in vision therapy are more responsive to educational instruction than children who do not participate. *Pediatrics* 2011;127:e818–e856

Bottom-up

CLINICAL AND EXPERIMENTAL
OPTOMETRY

INVITED REVIEW

Identifying and characterising cerebral visual impairment in children: a review

Clin Exp Optom 2014; 97: 196–208 DOI:10.1111/cxo.12155

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Submitted: 14 January 2014
Revised: 5 March 2014 Accepted for publication: 24 March 2014

Cerebral visual impairment (CVI) comprises visual malfunction due to retro-chiasmal visual and visual association pathway pathology. This can be isolated or accompany anterior visual pathway dysfunction. It is a major cause of low vision in children in the developed and developing world due to increasing survival in paediatric and neonatal care. CVI can present in many combinations and degrees. There are multiple causes and it is common in children with cerebral palsy. CVI can be identified easily, if a structured approach to history-taking is employed. This review describes the features of CVI and describes practical management strategies aimed at helping affected children. A literature review was undertaken using 'Medline' and 'Pubmed'. Search terms included cerebral visual impairment, cortical visual impairment, dorsal stream dysfunction and visual function in cerebral palsy.

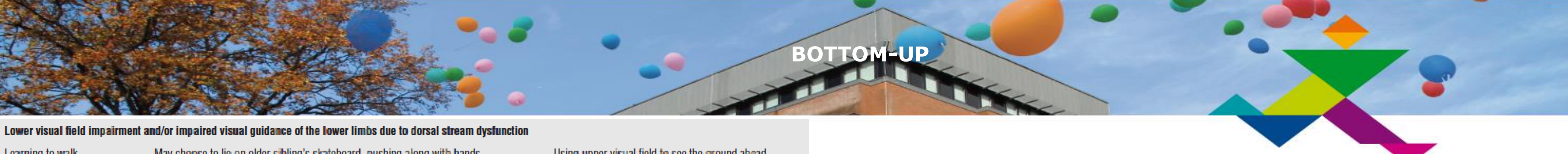
Key words: cerebral visual impairment, dorsal stream dysfunction, habilitational strategies, ventral stream dysfunction, visual perception

BOTTOM-UP

Difficulty	Behaviour, adaptation and approaches taken	Possible explanation
Low visual acuities for distance and/or near		
Unable to see facial expressions or recognise people, unless up close.	Families interact within the facial expression recognition distance, as do perceptive professionals. A black moustache or dark lipstick provides sufficient contrast for smiles to be seen.	Low visual acuity leads to faces being blank and meaningless beyond a critical distance.
Unable to see pictures and text.	Getting close to gain geometric magnification, enlargement of text and images, optical magnification, CCTV and computing magnification are all used	Low visual acuity makes access to sub-threshold detail difficult
Unable to see to navigate.	Assisted by an accompanying sighted person. Mobility training is implemented early.	Low visual acuity precludes identification of obstacles, hazards and landmarks
Unable to see in the distance.	Many families with older affected children find that a mobile phone with a camera allows distant targets to be found, identified and enlarged on screen.	Image crowding can be minimised. In nystagmus, near acuity is often better.
Unable to see for near	Enlargement of near materials to be within the limitations of functional visual acuity Correction for even small degrees of hypermetropia can be helpful, as well as a near correction in some cases	Lenses for hypermetropia and correction for poor accommodation enlarge and bring into focus
Coping with spectacle wear		
Spectacles are uncomfortable.	Glasses are removed. They may need adjustment for fit. Repeatedly, putting them on again in a gentle but firm manner usually proves successful.	Some children with cerebral palsy appear to be more sensitive to touch.
Spectacles for myopia interfere with near vision.	Spectacles (that make the eyes look smaller) are removed and material is held very close to see.	Myopia (without glasses) gives near magnification, with less crowding. Glasses may make things so clear as to cause visual discomfort in cluttered environments
Spectacles can be tiring to wear all day.	Spectacles are removed when tired.	Blurred vision can be more comfortable for children with visual crowding difficulties.
Impaired perception of movement		
Small animals cause distress.	Affected individuals startle and are upset by fast moving small animals.	They seem to appear from nowhere due to dyskinetopsia or slow visual attentional processing.
Unable to move quickly.	Moving quickly makes things disappear.	Impaired movement perception.
Traffic is not seen.	Cross at pedestrian crossings.	Only slow traffic is seen.
Fast movement not seen.	Choose to watch TV and film with limited movement and avoid fast moving films.	Dyskinetopsia precludes perception of fast movement.
Occasionally misses language within fast facial expression.	Families and professionals need to use words to express their feelings and emotions and give prolonged facial expressions to render them all visible.	Fast facial expressions are not seen due to dyskinetopsia but slow ones and expressions in

BOTTOM-UP

Visual field defects and hemianopic lack of visual attention (Recognising that many with hemianopia have good compensation and that the hemianopia may interfere less with daily living with time.)		
Miss food on one side.	Rotate the plate. Those lacking attention on one side find food if the plate is decentered to the sighted side, or chair is slightly rotated, 'better side' to table.	Food is not seen or attended to on the affected side
People not seen on affected side.	Teachers, friends and family find they need to communicate from the side with best visual function. Child is seated in class with teacher to 'better side'.	People are not seen and may not be attended to on affected side.
Traffic missed on affected side.	Mobile children may need to turn bodily to look to affected side because unilateral lack of attention, which may accompany hemianopia, relates to the body rather than the head and eyes.	Inattention relates to the body schema and may not be compensated for by head and eye turn only.
Toys and material in books not seen on affected side.	Toys and books displaced off centre to the unaffected side for play and study but placed at times on affected side to motivate search.	Motivated search towards affected side may improve attention.
Ventral stream dysfunction. (Isolated severe ventral stream dysfunction with good visual acuity is rare. Affected children are able to move around with their intact dorsal stream dysfunction and appear sighted, yet what they are looking at is not easily recognised. Ventral stream dysfunction is more commonly identified as an accompaniment to dorsal stream dysfunction.)		
Lack of orientation within surrounding environment (topographic agnosia).	Child is easily lost, even in places that are known. Orientation in the classroom can be assisted by colour-coded lines on the floor (in marked cases). Colour coding of doors in the home is used by some families. (The disorientation of ventral stream dysfunction is more marked than the clutter-induced disorientation of dorsal stream dysfunction.)	Temporal lobe damage can lead to severe impairment of recognising and navigating surroundings (topographic agnosia).
Difficulty or inability recognising people's faces (prosopagnosia), and the language of facial expression.*	A young child may turn her parent's head to look straight at her to render it easier to recognise. Alternative identifiers such as colour of clothing, voice recognition or recognising the footfall, may be so well substituted that the deficit may not be recognised for many years. Family may go out together wearing clear identifiers such as bright coloured clothing. Affected children and adults may not look at people's faces when communicating.	Prosopagnosia accompanies damage to a structure called the fusiform gyrus in the temporal lobe, additional lack of ability to see language conveyed by facial expression is common.
Difficulty or inability to recognise animals.	Four-legged animals may be indiscriminable, even when they are moving. Families may adapt by taking the child to children's farms where the animals can be experienced up close.	This problem occasionally accompanies prosopagnosia.
Difficulty recognising objects (object agnosia).	The child may pick up one object after another before identifying and retrieving the chosen one by means of touch.	Tactile recognition is being used instead of visual object recognition.
Difficulty identifying family car in car park.	Colour instead of shape tends to be used, so that it is easy to miss the car. Some families use a distinct identifier.	Object agnosia results in alternative less robust recognition strategies.



BOTTOM-UP

Lower visual field impairment and/or impaired visual guidance of the lower limbs due to dorsal stream dysfunction

Learning to walk.	May choose to lie on older sibling's skateboard, pushing along with hands	Using upper visual field to see the ground ahead.
Walking without tripping or bumping in to things.	Wants to take a push-along wheeled toy wherever possible.	Provides tactile guide to the height of the ground ahead and affords a mobile protective boundary.
Unable to see ground immediately ahead.	Paradoxically tends to run from place to place.	May enable the child to get to the more distant seen ground before it is lost from memory.
Jumping off a wall or a bench.	Refuses to do so or is prepared to fall over or may have already been taught how to do a commando roll.	Cannot see the ground to land on.
Jumping/diving into a swimming pool.	Frightened of doing so.	Cannot see or judge the height of the water.
Walking down slopes or over uneven ground.	Finds it difficult. Holds onto clothing or belt of accompanying person, while pulling down and walking slightly behind. Prefers not to hold a hand, unless it is consistently extended and held backwards. Older child may simply touch elbow of accompanying person. The mobile child may prefer to use a stick, walking stick or hiking poles on country walks.	These strategies provide a tactile guide for the height of the ground ahead, with advance notice. (A 'loose' hand gives no such guidance unless it is extended and the elbow fixed to give a consistent tactile height guide.)
Walking downstairs.	Finds it difficult. Initially goes down step by step on backside. Later uses bannister with both hands and goes down sideways. When older, may use heel to slide down each stair riser to judge height.	Cannot see the stairs going down and has difficulty estimating their height.
Going down slides.	May refuse to go down a slide while sitting. May insist on going down head first.	With a seated posture the slide below cannot be seen, but with a lying posture means that it can, in the upper visual field.
Negotiating escalators.	Avoids escalators and uses lift	Stepping on to a moving surface is very difficult.
Difficulty crossing floor boundaries or walking over patterned floor, like tiles or carpet.	Uses a foot to probe the height of ground ahead when there are floor boundaries or large patterns, especially in new places. Plain boundary-free floor surfaces in the house may be needed.	Those affected look down and use central vision to inspect floor boundaries and pattern, yet still probe with the foot, suggestive of additional impaired visual guidance of movement of the feet.
Cannot estimate height of the bottom of a bath.	A coloured bath mat and handrail can help. Often the child prefers to use a shower.	Lack of clearly visible contour renders the height of the bottom of the bath difficult to estimate.
Misses the bottom of the TV screen.	Chooses to lie on back on the ground or on sofa or chair and to watch TV upside down or chooses to watch TV from below.	Child prefers to use upper visual field to watch TV despite the picture being upside down, and habit persists.
Putting shoes on.	Lifts foot high onto step or lies on back lifting the foot to do so.	Cannot see feet well enough in lower visual field.
Finding shoes on floor.	Allocate shoes in a specific location on floor or on a higher surface.	Shoes and other possessions often lost when on the floor.
Avoiding and negotiating low obstacles.	Coffee tables are bumped in to especially when moved. The child can become angry if this happens. (Families have often removed them or have ensured that they are in a fixed location and they involve the child in moving furniture.)	Position of items in lower visual field is difficult to see and estimate.
Wheelchair users cannot find items on their tray.	Parents have found that tray needs to be elevated and or moved further away, to become visible.	Items need to be visible by being placed in area of intact visual field.
Cannot see hand for a handshake.	Avoids hand shakes.	The proffered hand may not be seen and this can cause embarrassment.
Cannot see friends when looking down into a crowd.	Family recognise this problem and wave and call out.	Lower visual field impairment impairs search in lower visual field.
Difficulty reaching for items.	Automatically uses a wide finger gap or an outstretched hand when reaching for an item or reaches beyond item and gathers it up.	Variable combination of lower visual field impairment with dorsal stream dysfunction renders hand movements clumsy and the child compensates automatically.
Difficulty seeing buttons.	It is difficult to do up buttons but this task may be found to be much easier in front of a full-length mirror.	Buttons cannot be seen even when looking down if the visual field impairment involves the whole lower visual field but they can be seen in a mirror.
Difficulty putting items down.	Items are often misplaced. Child may have already learned to use little finger as a tactile guide to locate and estimate height of surface.	Visual guidance of movement needs to be supplemented by touch for putting items down (especially when tired).
Misses the lower part of a page.	Prefers text to be held up high, or placed on a book or music stand. Text placed further away on desk allows lower part of page to be read more easily.	Although one reads with the centre of the visual field, the lower visual field conducts gaze down the page.

Disability giving attention to more than one issue at once.

Will not look at a face and listen at the same time.	Looks away from people when listening to them.	Disability giving attention to the face and the spoken word at the same time.
Difficulty seeing and listening at the same time.	Appears not to see when listening, in severe cases.	Profound difficulty dividing attention between sight and sound.
Great difficulty copying.	Prolonged imperfect copying of information.	Impairment of the dual task of visual search of sourc and target documents, while remembering the information.
Cannot see all the information on TV screen.	Chooses to watch material with slow presentation such as the weatherman. Gets very close to the TV, shifting the head and eyes to the elements that attract attention.	The combined fast image movement and multiple details mean that it is easier to get very close to the TV to see it even if visual acuities are normal or near normal.

Difficulties due to dorsal stream dysfunction

Finding a relative or friend amongst a group of people.	Parents learn to meet in specific locations, to wave, to call and to wear distinct clothing when meeting child from school, or when going out as a family. They 'know' this is 'normal' for their child. Older child may use a friend or sibling as a guide or stay at the side of the playground knowing it to be normal not to be able identify friends. Informed friends can adapt by 'adopting' and helping the child.	Impaired ability to identify a person in a group due t impaired visual search is a typical feature of dorsal stream dysfunction.
Easily gets lost in crowded places.	Avoids crowded places, which can be distressing. Older child and adult know that it is normal to frequently ask for directions. Families have found that mobile phones are essential for older children, who can contact them if they get lost. (Inability to locate where sounds are coming from can mean that calling out to the child may not help.)	Crowded places with a lot of people and noise cause confusion.
Easily gets lost in busy towns and shops.	The young child can wander and get lost. Visits tend only made to known locations with limited distraction. Families have learned to visit places when quiet to learn the 'lie of the land' in advance.	Town centres and shops can present too much visu input to analyse.
Items pointed out in the distance cannot be seen.	Some parents physically rotate the child towards the target and get them to look along a pointing arm. Digital cameras with a zoom facility can assist considerably.	The further away one is, the more there is to see. (Except eg. for aircraft in the sky, which are more often seen.)
Difficulty finding toys.	The child tends to: Empty the toybox and spread toys out; line toys up; ask a parent/carer to find the toy; choose a random toy instead or not bother with toys. Sparce well-placed toys, in a plain uncluttered space overcome this difficulty.	The 3D muddle of the contents of a toy box is difficult to cope with.
Gets very close to the television.	Watches separate elements of the television, shifting attention and gaze to items that attract attention.	Impaired visual search limits how much can be seen
Does not watch cartoons and films with a lot of visual and auditory information.	Either does not watch TV or watches the newsreader or weatherman or similar programmes with limited visual content. Films made before the invention of the zoom lens, where there is no zooming or panning may be preferred	Impaired visual search limits how much can be seen
Impaired reading of crowded text.	Limit amount of text per page and limit background clutter. Some children learn to occlude surrounding text by using their fingers, a ruler or a self-made typoscope (an occluder with a slot cut out). A minority have already identified appropriate computer software (eg ACEreader)	Impaired visual search can affect access to the written word. This can, in some, be overcome by minimising crowding with a typoscope or well-spaced text layout.
Impaired ability to access numbers from the printed page.	Some children find that this difficulty relates to an inability to access columns or rows of numbers accurately unless they are both presented and written on squared paper.	Visual crowding can lead to numbers in columns an rows becoming jumbled.
Inability to identify and find items of clothing from a pile.	Clothes get spread out to find chosen item. This can cause conflict. Using small numbers of items of clothing placed in specific locations, or hung up as sets helps deal with the problem. Teaching the older more able child to iron and sort each item of clothing warrants consideration.	A partially covered item of clothing can be difficult t identify.
Problems finding items on school work station.	The school work-station and tray easily becomes messy and disorganised. Strategies such as a template of where to put things, can help deal with this difficulty.	Overlap of objects can mean that they are not identified and found.
Problems changing clothes at school.	Items of clothes can get mixed up. Some children learn that a strategy of hanging up clothes sequentially as they are taken off can be reversed successfully, for getting dressed again. (Dressing apraxia may be an additional problem.)	Overlap of clothing renders individual items difficult to find.

Discomfort and anxiety related to dorsal stream dysfunction		
Shopping in supermarkets causes distress.	Families learn to take child early or late when shop is quiet or avoid doing so. The younger child likes to sit in the shopping trolley. The older child may like to push a small shopping trolley to feel safer (but this can be difficult to manage). The child who gets lost is difficult to find and cannot identify where a calling voice is coming from. Older children can be given mobile phones to cater for this.	The visual and auditory noise, accompanied by inability to know whether shopping trolleys will collide into one, can be very distressing.
Tantrums in busy places.	The distress caused by busy places can cause tantrums, which are difficult to manage. Families have learned to avoid these situations with the child. Retreating to a calm quiet environment can be effective.	The visual and auditory 'noise' combined with inability to escape becomes overwhelming.
Unable to go to family events and parties.	Many families have adapted by going early, when quiet and allowing the party to build up; taking the child away if distressed.	Gradual build up of crowding is less distressing.
Distress on car journeys.	More profoundly impaired children can be distressed by the sensory input from car journeys. Parents may have found that window shields or dark glasses diminish the visual stimulation, while playing music through headphones can provide sufficient distraction	Engine noise and the moving scene can be distressing
Impaired visual guidance of movement of the upper limbs. (Motor difficulties may mask aspects of impairment of visual guidance of movement but for those with little or no motor difficulties, impaired visual guidance of movement [optic ataxia] may be evident as the principal problem.)		
Inaccuracy of reach.	The in-flight movement of the hand is not matched to the spatial location. The gap between finger and thumb is wide or a whole hand is extended to grasp the target object or the object is gathered up. Some, with good control of movement, learn to extend a little finger or the other hand, as a tactile guide to the location of the target surface can avoid misplacement of an object. Objects may need to be enlarged to facilitate grasp. Touching the table with part of the body, can improve accuracy.	The posterior parietal cortices are damaged leading to optic ataxia, commonly accompanied by simultanagnosia. (This may be misdiagnosed as dyspraxia or being motor in origin.)

TROUBLES NEUROVISUELS CONCLUSIONS

- Les troubles neurovisuels
  - Sous-diagnostiqués
  - Contribuent aux troubles des apprentissages
  - Tests de dépistage existent mais nécessitent d'être évalués pour voir ce qu'ils apportent au patient
  - Chaque patient est différent
- Comorbidités sont la règle
  - Infirmité motrice cérébrale, dyspraxie
  - TDAH
  - Dyslexie, dysorthographie, dysphasie
- Prise en charge
  - Adaptations au cas par cas, pas d'études qui montrent une généralisation possible de la prise en charge