General Medicine

Original Article

Magnetic Resonance DTI analysis of Phonological Awareness and Object Naming Speed in children from 3 to 5 years old: An Orthotropic Radial Analysis of Inferior Longitudinal Fasciculus

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Abstract
Phonological Awareness and Rapid Object Naming are related to Reading Skills. In this work, the correlation between performance in the first variables with the development of the Left Inferior Longitudinal Fascicle was studied. For this, a novel method of Magnetic Resonance was used without the need for sedation in boys and girls from 3 to 5 years of age. Orthotropic-radial hypothesis contrasts were performed to test whether the entire fasciculus was part of the correlation or there were more closely associated radial and longitudinal divisions (hypothesis of non-homogeneity of white matter tracts). The evidence supported that only some parts of the fascicle had a significant correlation with the cognitive variables of interest.

Introduction

For sixty years, Phonological Awareness (PA) has been proposed as an antecedent involved in learning to read (Zhurova & Elkonin, 1963). PA is defined as manipulation and control of the linguistic structures that makes up an adequate configuration of a word (lexemes). Associated phenomena to PA are to spell, syllabic decomposition, recognizing a word in an image even if a phoneme has been removed. The first formulation of a conceptual model of PA was made by Wagner (1986), who three years earlier had already proposed a conceptual structure of PA but in a broader theoretical context. In the frame of Sloyd Scandinavian Education countries (Page et al., 2009) was deigned the first PA training in education (Wagner & Torgesen, 1987).

Wagner differentiated PA from Object Naming Speed (RAN, by Rapid Accuracy Naming, is the accepted acronym for this concept) although he proposed both variables correspond to a single function to the working memory phonological loop [3] (Baddeley, 2009). Wagner's model predicted that simultaneous retention for 1 second of three words allows to the present human time the manipulation of sub-elements of linguistic objects. Then, the core of PA is the degree of control of these sub-elements. The link between PA and Reading Skills (RS) began as a debate about a possible anticipation role of PA on reading acquisition. A theoretical loop emerged because the development RS run in parallel to PA and RAN increase (Makhoul, 2017), then RS could improve its proper level influencing PA and RAN.

Wagner's model was based on the English language, which has a moderate opaque score in the transparency range of all languages. Language Transparency Level (LTL) refers to the transfer of information between grapheme, phoneme, and morpheme, and the variable difficulty which language intrinsically involves on communication. It was discussed if load on phonological capacity of working memory was moderated by LTL (D'Alessio et al., 2019). The first study about LTL as a moderator between working memory and PA-RAN emerged from German researchers, who hypothesized that cognitive inferences coming from English language could not be applicated to German language because their languages LTL divergences (Brandenburg et al., 2017). But LTL was distant to be serious, the study entitled Reading and Phonological Awareness in Africa (Alcock et al., 2018) was trapped between the excessive ambition of the title and the fact that consists of a psychometric work carried out with 85 children in a vaguely nomenclated 'rural area of Tanzania'.

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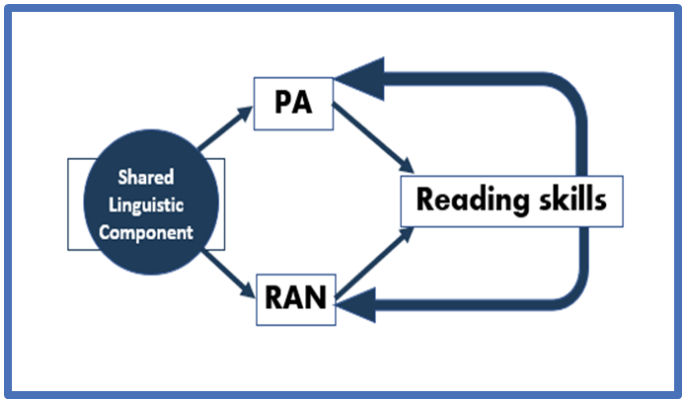
However, this discussion opened new insights considering researchers about Arabic languages. The PA research tradition on Arabic is fundamental since it involves processes those other languages do not have, such as production of meaning from the temporal separation of the same grapheme when converted the phoneme discontinuation a key variable for an understandable semantic, specifically about how to manage the closure of the air inlet in order of the grapheme (Asadi & Abu-Rabia, 2019; Makhoul, 2017; Saiegh-Haddad et al., 2020; Schiff & Saiegh-Haddad, 2018).

Deeper knowledge about PA also came from studies in Colombia (Soto et al., 2019), China (Zhang & Roberts, 2019), Iran (Farahani & Talebinejad, 2018.), and India. When world language representation is better supported, the hypothesis that working memory optimizes their functioning for each LTL gained on evidence. As a first reviewing conclusion, Working Memory sub- functions are relevant to develop PA for RS according to the LTL level that the language environment demands.

When technologies of neuroscience like Magnetic Resonance (MR) were incorporated, caused a qualitative jump in PA research (Landerl et al., 2019). From both functional (fMRI-dynamic causal analysis) and structural (mainly on Diffusion Tensor Imaging DTI models) PA and RAN influences the level of RS as partially independent factors. But literature of training RS is clearly dominant to RAN training in scholarship, justified in a feed forward process where both PA and RAN are included in an elegantly called 'eternal golden braid' (Hofstadter, 1979).



Longitudinal studies with children not able to read (generally lesser 5 years old) had the difficulty that MR requires a minimum amount of head movements, for which the admitted children were of an age at which it was expected that they already have developed RS (De Vos et al., 2020). If evidence doubt of the interaction between RS and the development of PA-RAN are in the spot, an experiment directed to shed light about the temporary sequence requires that participants does not include readers. But this difficulty was solved by Thieba et al., 2019, then children without RSs were scanned, assessed in PA and RAN, applying a complex behavioural- playing method. However, Benetello et al (2016) advised there was a diversity of instruments to assess PA, RAN and RS conspiring against a well-established model by the lack of depth in the aspects of abstraction, conjunction and composition in the stimuli that measure PA and RAN. Adding measures as a compensatory decision do not look like a solution.

The most direct antecedent of our work is a PA and RAN DTI study on 6 to 7 years old children focused on the inferior prefrontal gyrus, medial temporal lobe and parieto-temporo-occipital juncture (De Vos et al., 2020; Powell & Atkinson, 2020). The problem with these works relay over children maturation processes and DTI- data control (Colby et al., 2012; Lebel et al., 2012; Lebel et al., 2019; Thieba et al., 2018). They reported Fractional Anisotropy (FA) and Mean Diffusion (MD) of canonical WMTs, without any reference to orthotropic-radial-eccentricity statistics (Marino Davolos et al., 2020). FA is mainly interpreted as a measure of fibrillar coherence (Steffens et al., 2011), then the whole white matter tract compaction degree depends on water molecules diffusion, as stated by Beaulieu et al., 2005; Hofer & Frahm, 2006; Kersbergen et al., 2014; Liao et al., 2013; Shany et al., 2017; Steffens et al., 2011; Takeuchi et al., 2013 . Although the FA mathematics came from the same data source like MD, MD level was associated to a pathological condition, as lack of myelinization (Assaf & Pasternak, 2008; Koenig et al., 2015; Mattson et al., 2017). The relationship FA|MD has a complex simultaneous lineal and logarithmic regularity that should awake suspicious that they cannot represent independent biological factors. Both FA|MD are fractional expressions employing l1, l2 y l3 of diffusion tensor values (Leemans & Jones, 2009). But mainly, the cornerstone of the problem is that brain structural connectivity is explained by neuronal firings through fibrillar white matter, and FA|MD came from a segmented tract packed by water molecules detection.

Relevant to the present study, we controlled the fiber-tracking process considering that water molecules transport is not directly related to electrical impulses. Then, inferring degree of brain connectivity needs additional steps of control. A bundle is constituted by thousands of fibers, then a controlled experiment needs to afford the null hypothesis that not necessarily the entire fiber would be involved on neural networks connectivity. A radial division of the fiber- tracking capture is necessary to face the possibility that only a part of the segmented white matter could be relevant for the FA|MD signal, despite of the entire coherence, onto a noise information architecture. Traditional DTI treated canonical WMT as homogeneous, longitudinally uniaxial entities, despite a non-homogeneous structure, with properties subjected to the pressure of orthogonal vector forces. Evidently, is an indirect method that demand a set of controls according to the nature of this strategy. Aging factors captured a progressive development of wave functions into the white matter tracts communication, where signal to noise ratio is curved along tract. These distortions were detected in sound stimuli applied on elastography (Rui et al., 2016).

Then, the present study considers that is necessary to control the null hypothesis that brain connectivity reports of MR-DTI-WM streamline based applying an orthotropic- eccentric approach (Marino Davolos, Jefferies & Arias Haro, 2020). Basically, the null hypothesis is that not all of the segmented fibers are involved in carrying on information, then, reported FA-MD connectivity values of whole tracts could include measures of coherence not related to brain connectivity (Chen et al., 2015).

Pilot studies converting natural geometry of captured fibers into a radial topology, found higher FA in the centric rings. Also, the outermost radial rings were characterized by high MD and inversely lower FA. However, longitudinal pilot studies suggest that could be a "migration" process where MD values changes conjoined to FA values in the same participant, tract, and cognitive variable, at different age. Our purposed method follows a mathematical rhythm during the contraction (from outermost ring 9 to the centric ring 1, step by step) of each

tract (Leemans, 2020). Also, in pilot studies we found MD and FA experienced three regular changes: After a progressive increase in MD (rings 9 to 7), follows a conjoint increase in MD & FA (rings 6 to 4), then appear a sudden increase in FA that significantly change statistics (rings 3 to 2). When arrived to ring 1, we found a stagnation of both MD and FA. In all cases, MD had greater stability, while FA showed a higher standard deviation.

That pilot studies encourage us to design and run this experimental study including this set of variables: a) Phonological Awareness b) Rapid Automatic Naming c) Fractional Anisotropy of Left Inferior Longitudinal Fasciculus (lILF) d) Mean Diffusion of lILF e) developing age of cognitive variables- children of 3 to 5 years old f) post processing of iILF following all high- quality steps of diffusion data- streamline analysis g) radial-concentric control of brain connectivity measures.

Material and methods

Participants

That study belongs to a set of studies performed by Calgary and Edmonton's Universities, Canada. To see details, is necessary to go to Reynolds et al (2020) published work and open supplementary data. The following is a brief of that: Children were recruited from the local community and from an ongoing longitudinal study in Alberta State, Canada; all children lived in the Calgary area. MR data were recruited from 74 children (33 males, 41 females). Children ranged from 3 to 4.9 years (mean ¼ 3.66 ± sd 0.43) at the time of their first scan and were initially invited to return at six-month intervals; most of them continue an annually following. All children were free from genetic disorders and controlled by significant intellectual or motor impairments. All were born into ˜ 35 weeks gestation. Parental/guardian written informed consent, and child assent were obtained for each participant. Ethical approve was exposed and published in the referred Reynolds et al. article. Anonymized behavioural- demographic database was straight. Acquisitions were performed in Developmental Neuroimaging Lab at the University of Calgary.

Materials

Diffusion Weighted Images- Acquisition

Acquisition data were performed in the Calgary preschool MR project (Canada, Alberta, Calgary). Details of this process are in Reynolds et al (2020), including free access to the NIFTII files to replicate data. The Stejskal-Tanner equation was pragmatically solved contrasting between S1 (diffusion-weighted images) and S0 (without diffusion-weighted). Contrast values were: b = 750 (x30) versus b = 0 (x 5). Basic acquisition parameters were Echo Time (TE)= 79 msecs, Repetition Time (TR)= 6750, Voxels mm3 = 2.2 x 1.6 x 1.6 (resampled on scanner to 2.2 x 0.78 x 0.78), FOV= 20, encoded directions= 30, non-weighted images= 5.

Psychometric data

Variables were measured with NEPSY-II (Davis & Matthews, 2010). The Phonological Processing subtest assesses Phonemic Awareness (PA), and the Speeded Naming subtest assesses rapid semantic access, and production of names of colors and shapes (RAN) (Korkman et al., 2007). Also, NEPSY II Selective Concept Retrieval (SCR) and Rapid Serial Numbering (RSN) were applied, but not considered in this study.

Proceeding

The software-tool used for the control of null hypothesis analyzes was JACtree (Marino Davolos, Arias Haro & Jefferies, 2020). JACtree is a software developed using linear algebra, running over matrix algebra platforms, with a strong communication with ExploreDTI software (Leemans et al., 2009). JACtree has numerous tools that allow both deconstructing the uniaxial approach as well as plugins linked to all software related to Diffusion Data-Streamline data based. Eccentricity's WMT was measured with Contractio, a JACtree tool. Rings were delimited using centroids based on along streamline analysis, an improvement of a previous tool (Binney et al., 2012; Colby et al., 2012; Makris et al., 2005). To complete the explanation of radial analysis we suggest reading JACtree manual (Marino Dávolos, Arias Haro & Jefferies, 2020), specially how to treat with sophisticated topologies of WMTs physiology.

Uniaxial conception depart with canonical WMTs can be represented by single statistics (Lebel et al., 2012). FA|MD represent the uniaxial statistics reported over the treatment of WMTs as uniform, homogeneous, without any reference to radial concentric orthotropic inhomogeneity in analysis. To deep a little in orthotropic radial eccentricity, a Procustrean effect is applied over streamlines forming WMTs. To account the distortion effect is necessary to calculate the reliability of Procrustean mathematics (Aben et al., 2019; Daboul et al., 2018). However, the distortion level has no significative impact, less than 3% of the length of the streamlines has a Procrustean deformation. The key to the process lies in approach to the NifTII files of MR-DTI data using the combination of the streamline's scales of the variables: Median was used to face ordinal variables and mean to face intervalar and proportional variables, which constitutes the mathematical topological space of analysis of the streamline reconstruction process.

Echo-Planar acquisition system get several voxels that constitutes the native brain space. The JACtree null hypothesis control works on rings analysis, at first is necessary the codification by integrals of the two streamlines-topological sources 1) width and 2) length. Shaking width/length in two dimensions from three combinations (XY, XZ, YZ), Diffusion Tensor means the application of Einstein's diffusion equation over this first space transformation (Basser et al., 2000) information points. The four inputs that transform the streamline based-bundle in a cylindric radial object is feeding of the three planes of the Euclidean space plus Procrustean Math's Effect.

Contractio of JACtree is a tool-test the null hypothesis that WMT-DD could be representable as uniaxial material. Contractio main input is WMT diameter. Diameter is divided by 9 equally proportional portions, defining 9 rings without any theoretical significance. Progressively Contractio calculates FA|MD measures from outermost to centric ring. Each step throws two values, e.g. ring 9 vs ring 8 FA|MD and ring 9 vs rings 8:1 FA|MD. Ring 9 is deleted, continue ring 8 vs ring 7, ring 8 vs ring 7:1 FA|MD. The matrix Contractio M (□□, □□) is a longitudinal, radial matrix which empty cells progressively fulfilling with the iterative results. All pilot studies throw that WMTs in analysis were eccentric, heterogeneous, longitudinally, and radially significant differentiated.

As a first empirical insight Contractio results reached clear higher correlations coefficients to cognitive processes compared to traditional whole tract approach. Also, correlations in the orthotropic- radial approach differentiate a) MD significative correlations b) FA ones c) MD|FA as one coefficient indeed.

The following matrix represents an iILF of the sample after JACtree inputs modeling: in this case a simplified 3 x 3 matrix representing the longitudinal and radial dimensions:

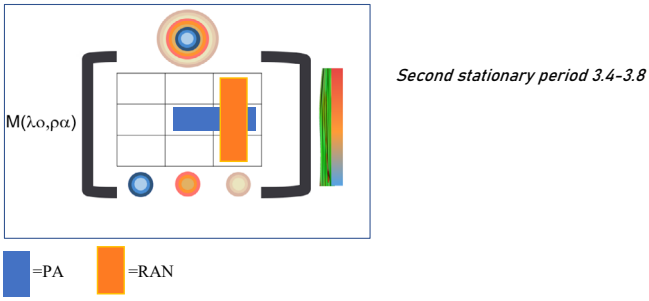


Figure 1. *Matrix of an Inferior Longitudinal Fasciculus of 4,4-year children*

We extracted one case of the sample using a random criterion to illustrate Contractio data- analysis. Alternative hypothesis of fiber-tracking states there would not be differences through the 9 rings of Contractio (tract homogeneity), but empirical results were the following:

ILF case X	FA	MD	Ci
ring1	,42135919	,90100865	1,96233260
ring2	,41410231	,90195451	1,98526998
ring3	,40786452	,90305479	2,00802199
ring4	,40463055	,90616135	2,02698843
ring5	,40105905	,90820928	2,04480241
ring6	,39595348	,91170943	2,07024310
ring7	,39491966	,91253029	2,07724307
ring8	,39255933	,91191084	2,08197839
ring9	,39022104	,91238556	2,09119513

a) homogeneity uniaxial alternative hypothesis predicts=100/100, Contractio index (Ci) found =127/100

b) null hypothesis test p = .795

A chi- square test were applied supporting the inhomogeneity of brain connectivity data considering radial approach.

Results

OIn Diffusion Data post-processing software, the statistical output highlight the relevance of Data Quality Assessment and detection of artifacts (Vos et al., 2011).

ILF canonical WMT was divided into three longitudinal segments and three radial rings. The segments were: (1) occipital, including rings (1,2,3), being 1 concentric, 2 medial, 3 outermost; (2) medial temporal (also rings 1,2,3) and (3) anterior temporal (rings 1,2,3). To facilitate the writing of the nine subsets belonging to the canonical ILF, the following code was used: (l1, r1,2,3); (l2, r1,2,3); (l3, r1,2,3). All subjects were included in the following statistics.

First a repeated measures ANOVA of FA as dependent measure was performed to compare ILF canonical WMT segments (l1, l2, l3). The descriptive statistics were the following:

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Discussion

This study reports 8 cases of myelopathy of syphilitic origin observed at the University Hospital Center of Conakry over a period from 2010 to 2019. These are all presumed definite cases whose diagnosis was made in the neurology and imaging department of the University Hospital of Conakry. It is well established in current publications [10,12,13,15] of the presence and persistence of syphilitic myelopathy, as a nosological entity of neurosyphilis. These authors emphasize the preponderance of atypical forms posing a real problem of differential diagnosis with other causes of myelopathies [7].

Tsui E et al [16] described a rare form in a 52-year-old woman with paraplegia and diffuse lesions throughout the spinal cord with intense T2-weighted images. In recent years, syphilitic gummies expressed by spinal cord compression patterns are increasingly described [18,19,20,21] and in the case of Molina-Olivier [18], the 47-year-old HIV-negative patient presented with syphilitic gummies confirmed by microscopy and polymerase chain reactions. These observations [18,19,20,21] show that syphilitic gums are not uncommon if they are systematically looked for as in our patient [4] who presented 03 hyperdense lesions (Figure 2) in a 38-year-old female sex worker without HIV. Clinically, the clinical pictures of syphilitic myelopathy do not differ fundamentally from those described in the literature [10,15,18-21], which are characterized by neurological manifestations, expression of a sensitivomotor spinal cord injury and more or less severe urinary sphincter disorders. Our patient 4 presenting several lesions is a rare specificity little described in the literature. In our study we did not observe any case of dorsal tabes in the form of a progressive medullary disorder affecting the posterior cords, expressed clinically by a sensitive ataxia, a loss of vibratory and painful sensitivity and vesico-sphincter disorders. In the tropics, the diagnosis of syphilitic myelopathy is difficult because of the multiplicity of spinal cord injuries of various causes: viral, infectious, parasitic, spinal vascular malformations, non-infectious myelopathies: Gougerot-Sjoigren syndrome, neurosarcoidosis, neuro-Behçet, and multiple sclerosis [1]. In a tropical environment, the differential diagnosis on the clinical level is evoked with tropical spastic paraparesis, HTLV1, medullary schistosomiasis, paraparesis of toxic, nutritional and metabolic origin: lathyrism, Konzo, B12 deficiency, adreno-myelo-neuropathy, hence the need to broaden the biological work-up labeled in these different pathologies and the need to search for associated lesions on encephalic MRI. Generally speaking, MRI shows one or more areas of intramedullary T2 hypersignal, the extent of which may sometimes involve several spinal cord segments. The caliber of the medulla is rarely changed. Our diagnostic criteria were based essentially on clinical, neuroradiological and serological data (VDRL-TPHA), hypercellularity with a predominance of lymphocytes and proteinorachy. However, several authors, notably C. Caudie et al [22], Mokri B [23], Hamelin A [24], Davis LE et al [25], emphasize the need to include in the diagnostic criteria parameters such as the IgG index and the Ig M and Ig A indexes, with the presence of oligoclonal bands, which may be contributory to the diagnosis of neurosyphilis, although Holmes and Lukehart state that the TPHA test is not widely used by certain teams working in the field of syphilis [26].

	FA Mean	FA sd
l1 occipital ILF	0,386	0,042
l2 middle temporal ILF	0,470	0,034
l3 anterior temporal ILF	0,398	0,044

Table 1. *Descriptive statistics of radial Inferior Longitudinal Fasciculus*

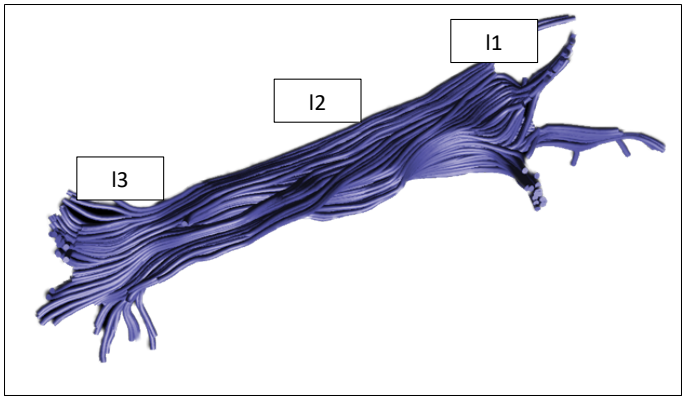


Figure 2. *Longitudinal division of Inferior Longitudinal Fasciculus*

A repeated measures ANOVA was performed entering factor LONGITUDINAL, RADIAL, and SEX as inter-subject factor. LONGITUDINAL FA (lo1, lo2, lo3). F = 31,649 (df 2, 57) p <0.0001; eta partial 2= 0,528. RADIAL FA (ra,1, ra2, ra3) F= 290,151 (df 2,57) p < 0,0001 eta partial2= 0,911. There was no interaction with sex.

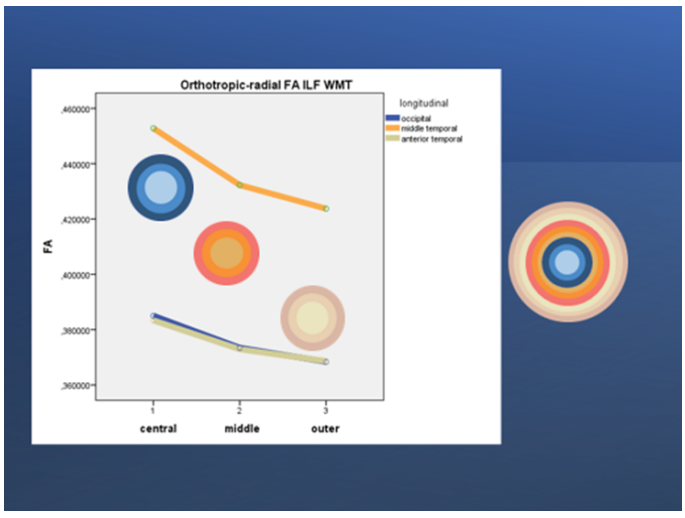


Figure 2. *Representation of radial and longitudinal differences in FA of lILF sample*

It was observed that ILF FA (lo2) had a significantly higher FA than ILF FA (l1,l3). Between ILF FA (lo1, lo3) there was no significant difference. Interaction between two factors was significant F= 3, 854 (df 4,55) p < 0,01 eta partial2= 0,251. The orthotropical-radial matrix [M (˜˜˜˜˜)˜˜] was composed by longitudinal ILF FA (lo1, lo2, lo3) crossing with radial ILF FA (ra1, ra2, ra3). The meanings of the terms were clarified enough to use the nomenclature of the orthotropic-radial software from here on. Then longitudinal=ro=˜˜ , radial=ra=ra, the˜˜ 3*3 describes the orthotropic-radial matrix modeling.

Descriptive statistics longitudinal, radial ILF WMT FA|MD		
	MEAN	SD
ra_1_lo_1_FA	0,38429923	0,04177685
ra_1_lo_1_MD	0,91207752	0,05372063
ra_1_lo_2_FA	0,45257545	0,03096701
ra_1_lo_2_MD	0,94594562	0,06458333
ra_1_lo_3_FA	0,38396677	0,04285075
ra_1_lo_3_MD	0,91125069	0,05677234
ra_2_lo_1_FA	0,37256125	0,04029319
ra_2_lo_1_MD	0,91549083	0,05898576
ra_2_lo_2_FA	0,43179902	0,02911154
ra_2_lo_2_MD	0,95982529	0,0744026
ra_2_lo_3_FA	0,37338887	0,03615269
ra_2_lo_3_MD	0,9161719	0,05287455
ra_3_lo_1_FA	0,36794121	0,03731387
ra_3_lo_1_MD	0,91589778	0,05294201
ra_3_lo_2_FA	0,42324205	0,03636763
ra_3_lo_2_MD	0,95413711	0,06353566
ra_3_lo_3_FA	0,36911882	0,03439975
ra_3_lo_3_MD	0,91970486	0,04736164

Table 2. *Descriptive brain connectivity statistics applying contrast null hypothesis method JACtree against tract homogeneity: Matrix size m*n.*

Subsequently, the MD values were calculated with the same procedure, lo F= 4,615 (df 2,55) p<.05, eta2partial= 0139, ra F=57,234 (df 2,55) p<.001, eta2partial= 0.410; There was no interaction lo, ro not sex.

Orthotropic matrixes and correlations with behavioral measures

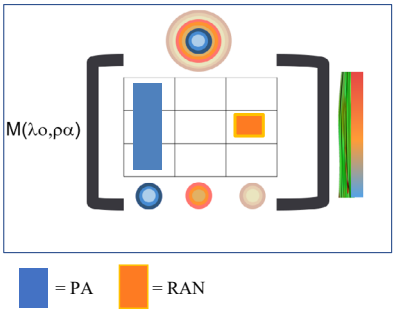
Behavioural measures were presented. The correlation values and their statistical significance are presented below. Each correlation was calculated with the Age covariate to detect if significant relationships were found to be associated with the time series.

Five stationary periods (sample years range/5) were analyzed in this sample. RAN and PA have a first stage of partial overlap, which fades at 4 years, and increases in coherence after 4.4 years, where it reaches its maximum correlation level (r = .383, p < .01). RAN reaches its maximum relationship with age (r = .579, p <.001), while RAN decreases its correlation.

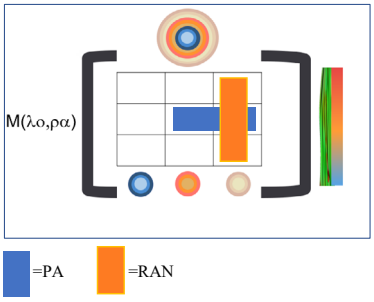
In contrast, the RAN correlation is significant and close to significance in the peripheral rings. From 4.3 years onwards, the structural brain connectivity measurements lose correlation.

In the fifth stationary period the relations between RAN and structural brain connectivity increase. They specifically focus on lo, ra [2,1 2,2]. The relationships between PA and FA|MD are not significant after 4.7 years.

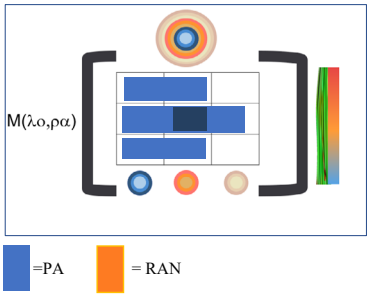
Age division was 3-3.4,3.4-3.8-3.8-4,4-4.4 & 4.4-4.8



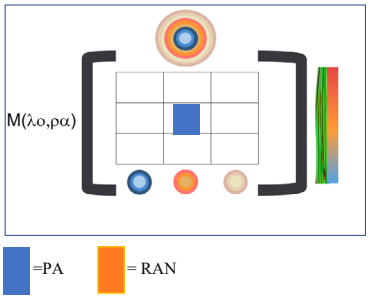
First stationary period 3-3.4



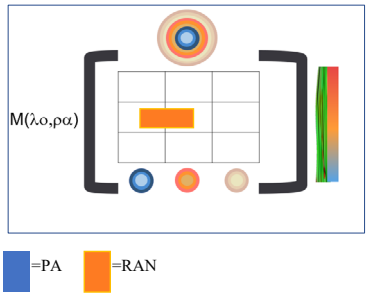
Second stationary period 3.4-3.8



Third stationary period 3.8-4



Fourth stationary period 4-4.4



Fifth stationary period 4.4-4.8

The usefulness of this study is to compare the habitual use of motus non cooperante statistics (mnc) to the orthotropic-radial- eccentric contribution. Orthotropic- radial approach would contribute to the structural brain connectivity relation to cognitive and affective processes based on the principle that white matter tracts are constitutive of cognitive and affective processes due to their intrinsic instantiated algorithms on to fibers architecture. But this complexity implies the non-homogeneity of the brain connectivity statistics extracted from an indirect way as water molecules diffusion. Behind these objectives it is underlying that motus non cooperante statistics maintains the philosophical soul-body dualism in a way that the WMTs are uniaxial material without the vicissitudes of a biological minded life. Motus non cooperante proceedings agree to the Cartesian dualism of the seventeenth century, because the tracts would be material which would be not relevant carrying out algorithms who participate in the recipe of cognitive and affective processes (Barrett, 2009b) (cfr 'The Descartes mistake' of Antonio Damasio).

Recently, a study was conducted in infants without sedation between 3 and 5 years of age to whom behavioral measurements of PA, RAN, accuracy in Rapid Serial Numbering (RSN) and Precision Conceptual Recovering (PCR) were applied, in a major study that implied DD-DTI acquisitions without the need for sedation (Thieba et al., 2018).

Structural acquisitions DD-MR in aged 3 to 5 years, conjoint with behavioral measures of PA, RAN, RSN and PCR produced a) publications derived from these acquisitions assuming WMTs as uniaxial materials, b) uniaxial approach assumed a radially homogeneous WMT structure c) uniaxial approach assume FA | MD are independent measures d) uniaxial approach conjectured FA | MD respond to independent biological factors, but e) reported results showed opacity mathematical issues in the maturation curves and e) ceiling effects in the behavioral measures of the aforementioned variables diminished the value of all data and ask for the presence of experts in cognitive process, regarding the magnitude of the achievement to scan without sedation little children (Lebel et al., 2019; Zhou et al., 2015).

All of that was a valuable opportunity to formulate the following objectives: 1) compare the uniaxial mnc approach to WMTs with orthotropic- eccentric over PA, RAN, RSN, PCR variables 2) inside that, highlight the statistics showing the independence or not of FA | MD measurements and their interpretation 3) test the software we developed under orthotropic- radial approach 4) include stationary measures, time series, and signal decomposition and cross correlations with delays, favored by longitudinal sampling.

JACtree carried out a careful and rigorous, analytic of the statistical transformations that extends from: 1) the readout of diffusion data to the 2) statistics publication of WMT in analysis specially over traditional microstructure coefficients that is supposed they measure brain connectivity indirect mechanisms, or processes. JACtree horizon is to improve knowledge of WMTs as cognitive -affective algorithms support. In traditional diffusion data post processing software clearly 'cognition' is an elusive concept. There is no history of software that relates both sets of variables with the seal of cognitive-affective process experts' viewpoint. Barrett (2009) cognitive primitives, also Amalric & Dehaene (2016) states that cognitive-affective processes are like a food recipe algorithm, cognitive capacities are ingredients. The product is constantly emerging

in a dynamic way. Each cognitive capacity is added in a step by quantity time, changing the behaviour (the food at Timex in this metaphor). Emergent process feed- forward step by quantity cognitive- affective mechanisms, including ones not previously part of the original recipe (like inhibitory control participation in a conversation turning to a conflictive one).

This territory of knowledge has been and still is an academic capital (Bourdieu & Passeron, 1990) of physicists and biomedical engineers. But, indifferent to human desires and ambition, WMTs generate, and not only transport, the algorithms of cognition and affectivity (Trevisiol et al., 2017). Technology disposables establish limits, but ideas expand limits.

The material represented by the stochastic process is compatible with an orthotropic, flexible one, under pressure from deforming stressors and with flexibility capacity. Operating with the (FA|MD) Mean WMT of subjects we found evidence of heterogeneity – eccentricity. Although data analysis is a pioneer work, and lack of research is a clear weak point, results suggests that WMT presents structural inhomogeneities but not chaotic. Canonical WMTs have a recognizable gestalt enough to detect a labeled entity as 'ILF' , but not to define the sensitivity the streamlines linked to the main associated cognitive processes.

Clinical data also support that WMT have an orthotropic eccentric structure radially inhomogeneous. Balo's multiple sclerosis (MS), prevalent in China (Chen et al., 2015) implode WMTs due to their inhomogeneous character, paradoxically (is a MS disease) resting intact both the myelin covert and the concentric rings. The author's cited that is possible that an intrinsic irregularity was the cause of that. To our point, we detected that streamlines of WMTs are composed by clearly different longitudinal points. While some streamlines have many variable FA values, appearing in extremely different points of an along tract analysis plot, other streamlines points, close in the geometrical space, appear stable on connectivity measures. Also, the relation between MD and FA needs to be explored beyond the traditional opposition FA (health) MD (disease), that is an oversimplification of the vectorial mathematics implied in the Tensor Diffusion, specifically considering the effects of rotation to reach an orthogonal disposition.

This work supports the hypothesis that the tracts have a microtubular compaction and consistency significantly more tense in the concentric rings, which favors their implosion given the characteristics of the pathology (as Balo's sclerosis show). At the same time, this same physical condition indicates that the amount of movement inside the tract would be lesser compared to the outernmost, due to oscillations in the amount of movement of the water molecules in a space of constrictions as measured by the increase in FA and decrease in MD simultaneously.

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